RETURN TO CD ROM TABLE OF CONTENTS

Dräger Medizintechnik

Anesthesia Workstation Julian 5132.000

Navigation Tips

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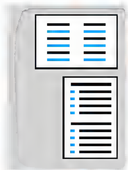
The icons on the left margin of the page are also hyperlinks. Clicking on them will have the following effects:



Opens the start page.

Opens the table of contents.

If you do not see these icons, then you have opened a "separate" file. If you want to return to the start page, just close this "separate" file. Such "separate" files are, for example, "Instructions for Use" and "Spare Parts List".

For information on how to use the Acrobat Reader, please refer to the Acrobat Reader Online Guide in the Acrobat Reader "Help" menu.

Table of Contents

Test Certificate

Test Equipment for Julian Test Certificate

Required Spare Parts (as applicable) for Julian Test Certificate

Safety and Function Test

Repair Instructions

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Schematics and Diagrams

Table of Contents

Schematics and Diagrams

Function Description

Pneumatics

Table of Contents

Table of Contents

Table of Contents

Function Description

Electronics

Table of Contents

Agent Analyzer (IRIA)

Table of Contents

Power Supply Unit and DC/DC Converter

Printer

Table of Contents

List of Conversions

Dräger

Test Certificate Julian

File-No.: 5132.000
Edition 09/99

DrägerService

Explanation of symbols

—	OK	C = Check condition
|	Defect	O = Check function
◯	Spare parts used	L = Check for leakage
/	Report	V = Enter test value
∩	Accessories missing	

Location of apparatus:: ______________________

____

____

Serial No.: ______________________

Date of delivery Startup: ______________________

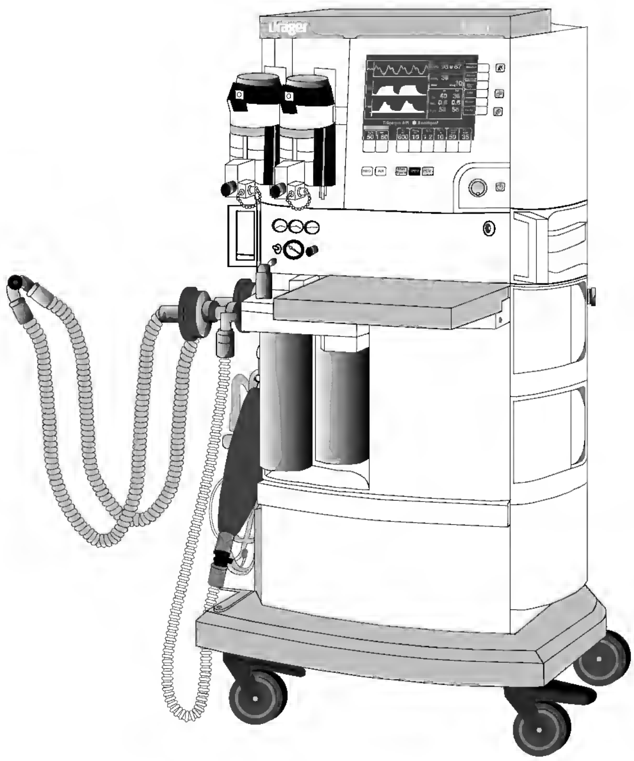
Invoice No. or delivery No.: ______________________

Others: ______________________

Note:

Vapor 19.n: see Test Certificate 5327.n
Devapor: see Test Certificate 5328.100.
Breathing systems: see Test Certificate 5132.010

USA: IPPV = CMV
France: IPPV = VC
PCV = VPC
Conversion table:
1 bar = 14.504 PSI
1 mbar = 1.01973 cmH2O



Serial numbers of breathing system

Cover: (The number is located at the edge of the APL valve disc).	V										
Valve plate: Number of the expiratory valve crater	V										
Number of the inspiratory valve crater	V										
Breathing gas block: Number of the PEEP valve crater (Roughly the first 100 breathing systems do not feature this serial number).	V										
Julian software version The software version is read out under test step 23.1. Enter software version here later.	V										

Overall Anesthesia Workstation

Note: When Julian is used in higher altitudes, make sure that service equipment is calibatred to the respective altitude. For flowmeter tubes, use the "Table for altitude compensation of flowmeters", item no. 7910698.

1. General condition of workstation

1.1	Check labelling and its legibility	C										
1.2	Touch-sensitive keys	C										
1.3	Writing tray, if fitted	C O										
1.4	Drawer, if fitted	C O										

1.5		Back-wall doors, if fitted	C O
1.6		Workstation rail/handles	C O
1.7		Castors and brakes, if fitted	C O
1.8		Hinged arm, if fitted	C O
1.9		Vaporizer plug-in system	
1.9.1	*	Replace O-rings (item no. U 04314) once a year.	C
		Date of next replacement: ______________	
1.9.2		Interlock system	
		Interlock mechanism: Check alternating function with vaporizers in position. Only possible to switch on one vaporizer at a time.	O
1.10		Anesthetic-gas scavenging	C O

Pay attention to corresponding tubing (filter, anesthetic-gas scavenging line or AGS system).

1.10.1		AGS system	C
	*	Replace particulate filter M 33294 if necessary. If one of the two excess gas connections is used: Check if screw plug is fitted in socket on side of AGS mounting system.	C
		AGS functional check: Connect AGS suction hose to anesthetic suction outlet.	C
		Float in AGS system flowmeter should move between upper and lower mark.	O

1.11		AGS system, US version		
		Perform functional test on flow control valve at outlet of AGS system. Turn flow control valve. Position of float in the flowmeter tube of the AGS system should change. Adjust flow control valve such that the float is in the middle position.	O	
1.12		Manual breathing bag and bag resuscitator	C	
1.13		Instructions for Use and device log available (ask user).	C	
1.14	*	Replace bacterial filter (8402868) in sample-gas return line every 6 months (does not apply to systems without sample-gas return line).	C	
1.15		Check breathing-system pneumatic interface. To do so, remove breathing system.		
	*	If necessary, replace Turcon rings (M 33899) with O-ring (M 33747) (tool 7910446).	C	
1.16		Flow-sensor plug and socket	C	
1.16.1		Flow-sensor socket resets	O	
1.17		Breathing system Check according to TC 5132.010	C	
1.17.1		Breathing-system interlock	C O	
1.18	*	Clean new fan mats (on back) at the latest after 6 months in use and replace them after 12 months in use (3 x 8601169). Date of next replacement: _____________	C	
1.19		Country-specific color coding of flush valve	C	

2. Bronchial suction system (optional)

2.1		General condition	C
2.1.1		Swivel fixture	C O
2.1.2		Telescopic extension	C O
2.1.3		Jar holder	C
2.1.4		Connecting hose (1203606)	C
2.1.5		Secretion suction hose (M 25780)	C
2.1.6		Jar caps	C
2.1.6.1	*	Replace float (M 26007) if necessary	C
2.1.6.2		Relief valve (if fitted)	C
	*	Renew mica insulator (R 17329) if necessary	C
2.1.7		Secretion jar (2M 85594 or M 20091)	C
2.1.8	*	Angled socket on device (if fitted). Renew 2 x sealing ring (R 50117, set of 10) if necessary.	C
2.1.9		Vacuum switch	C
2.1.10		Control valve/vacuum	C

2.2 Ejector operation (optional)

2.2.1	*	Replace bacterial filter CH 102 (set of 5, 6723976) every 6 months.	C

2.2.2 Functional test - ejector operation

Note:
A sticker beneath the rating plate of the anesthesia workstation indicates the pipeline pressure for which the bronchial suction system has been optimized.
5 bar or 3.5 bar

Testing:
Set up and connect complete suction system.
Connect O2 gas supply with appropriate pipeline pressure.
Set vacuum switch to 1.
Set control valve to max. pressure and seal off secretion suction hose.
Read off vacuum on Julian pressure gauge.

Capacity:
P = 0.7 bar in 10 s for pipeline = 5.5 bar
or -0.7 bar in 30 s for pipeline = 3.5 bar — O

End pressure: P_{stat} = -0.8 bar ± 0.1 bar — O

2.3 Vacuum suction system (optional)

2.3.1 Vacuum connecting hose C

2.4 Functional test - vacuum suction system

Testing:
Set up and connect complete suction system.
Connect vacuum hose.
Set vacuum switch to 1.
Set control valve to max. pressure and seal off secretion suction hose.

Vacuum should build up. O

2.5 Disconnect pipeline supply.

3. Pipeline supply

3.1 Pipeline connecting hoses

Check that equipment connectors, country-specific color coding and gas-specific coding are correct.

O_2 C

Air C

N_2O C

3.2 * Replace sintered filters (M 19238) in pipeline connection block every 2 years.

Date of next replacement: ______________

Note:
For the first 500 devices having a delivery date in the 2nd quarter of 1997, the NIST connections need to be removed in order to exchange the sintered filter, because the check valves block the access to the filter. Make sure the connectors are never interchanged on re-assembly.
The NIST adapter must be tightened to a torque of 12 Nm and the NIST DIN adapter to a torque of 9 Nm. Use socket wrench number 7910449.

3 x O-ring R 31296
3 x filter M 19238
(5 x O-ring M 30430
only required if NIST connectors are disassembled)
(5 x O-ring E 20264 or AF00352
only required if NIST connectors are disassembled)

Note:
On ceiling-mounted Julian units, sintered filter replacement involves detaching the cross-piece.

To access filters in US version of Julian, remove rear panel and pull out pneumatics section.

O_2	C										
Air	C										
N_2O	C										

---

4. High-pressure conversion kit (optional)

4.1 Cylinder pressure regulators
The numbers are stamped on the cylinder housing.

O_2, no.: ____________________________	C										
N_2O, no.: ___________________________	C										

4.1.1 * Replace diaphragm valve every 6 years (2312600). O

Date of next replacement: ______________

4.1.2 Replace sealing ring (flat packing ring for pin index safety system connection) of cylinder connection (refer to spare parts list) every 6 months

O_2	C										
N_2O	C										

4.1.3 High-pressure (HP) regulator performance test (once a year)

Date of next test: ______________________

Test set-up:
Remove HP connection hose from Julian and connect to flowmeter tube (7900718)

Open cylinder slightly to set supply pressure of approx. 10 bar.

Test:
With high pressure of 10 bar > 60 L/min.

O_2	O										
N_2O	O										

Connect HP hose to Julian. The HP cylinders remain closed.

4.1.4 Low pressure test and blow-off valve

Test set-up
Loosen the hex-head screw at the O_2 pressure regulator housing. Depending upon model, G3/8" or M10 x 1. (G3/8" for devices delivered in 1996 and beginning of 1997).

Connect Julian HP regulator to HP test cylinder with test pressure regulator (test equipment item number, see test step 8.3 of TC) using the following test equipment:

For G3/8" hex-head screw:
Connect adapter 7910718 to pressure regulator housing.
Connect 7910718 with adapter 7901435.
Connect PE hose 1194925 to reducer 7901459.
Connect reducer to adapter 7901437.

For M10 x 1 hex-head screw:
Remove connector from adapter 7901437 and connect to pressure regulator body.

PE hose	1202618
Adapter	7901437

Open HP O_2 cylinder. Test cylinder remains closed. Read low pressure at pressure gauge on the pressure regulator.

High pressure	Low pressure		
O_2 > 80 bar	2.7 bar to 5.5 bar	O	

Close HP O_2 cylinder and open test cylinder. Using the test pressure regulator, build up pressure until blow-off valve opens. Read opening pressure of blow-off valve on pressure gauge of the test pressure regulator.

Opening pressure O_2	5.7 bar to 8.5 bar	O	

Repeat the test described for O_2, this time for the N_2O pressure regulator.

High pressure	Low pressure		
N_2O > 45 bar	2.7 bar to 5.5 bar	O	
Opening pressure N_2O	5.7 bar to 8.5 bar	O	

Reinstall the hex head screw and close O2 and N2O Cylinder.

4.1.5 High-pressure gauges (if fitted)

O_2	C	
N_2O	C	

4.1.6 HP connection hose

O_2	C	
N_2O	C	

4.1.7 Checking HP sensor (US version only)

Carry out pressure comparison measurement every 6 months.
HP cylinders are closed.
Replace O_2 HP sensor with pressure gauge 7202974.
If applicable, replace copper washer D 04743.
Open HP cylinder and write down pressure value. V
Close HP cylinder.
Remove pressure gauge and replace copper washer D 04743. Mount HP sensor into pressure regulator.
Connect sensor to Julian.
Connect Julian to AC outlet.
Open HP cylinder.
Write down pressure displayed on 7-segment displays. V
The two pressure values may differ from the measured value by ±10%.
Close HP cylinder.
Check the N_2O HP sensor using the same method as with the O_2 sensor.

Pressure display with N_2O pressure gauge	V	
Pressure display with N_2O sensor	V	

Maximum permissible deviation: ±10%

4.2 Cylinders

4.2.1 If applicable, check and enter supervisory authority date (follow country-specific regulations).

O_2 every 6 years	C	
N_2O every 10 years	C	

4.2.2 Cylinder jackets

O_2	C	
N_2O	C	

4.2.3 Cylinder caps

O_2	C	
N_2O	C	

4.2.4 Velcro strap

O_2	C	
N_2O	C	

5. Replacing batteries, rechargeable batteries and nafion hoses

5.1 Replace lead-gel battery of the power pack (1 x 8601764) every 2 years. C

Date of next replacement: ______________

Notes:
New rechargeable batteries do not have a sufficient charge. After replacing rechargeable batteries, Julian must be left connected to the power supply for 10 hours so as to provide an adequate battery capacity in the event of mains failure. It may be appropriate to charge the batteries prior to installation (with Julian power pack at subsidiary/agency).

When replacing the power pack, always make sure that the stranded wires and wiring harness to the DC/DC converter are disconnected at the power pack. 24 VDC are present here even when the Julian is switched off - risk of short-circuit!

Further information on replacement can be found in the Julian Repair Instructions under "Replacing Rechargeable Batteries".

5.2 Replace the CIO PCB lithium battery (1835343) every 2 years C

Date of next replacement: ______________

Note:
Prior to replacement, record customer parameters in standby/configuration menu as well as flow correction factor, password and, as of software version 1.04, hours of operation using the service mode. After replacement, reset customer parameters, flow correction factor, password, hours of operation, and time and date.

5.3 Replace the Ventdos Controller PCB lithium battery (1835343) every 2 years C

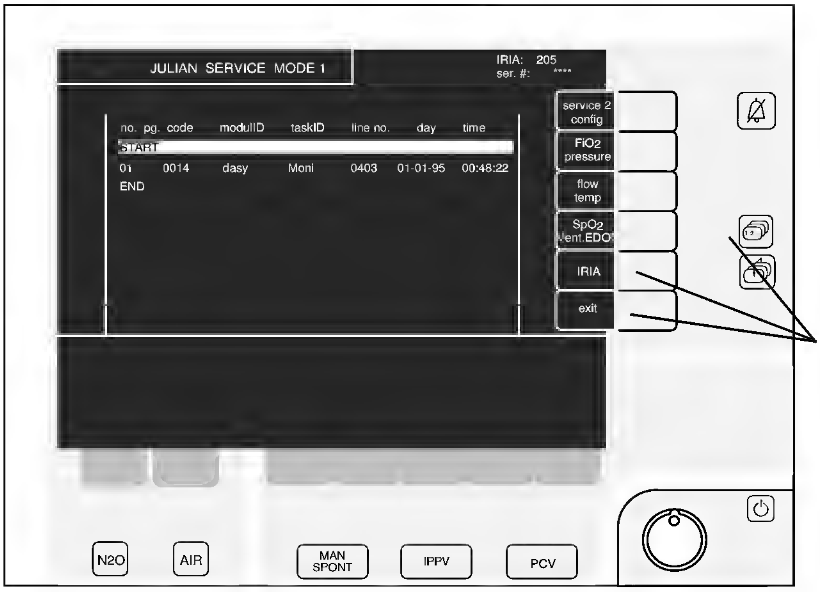
Date of next replacement: ______________

Note:
Replacement involves pulling out the pneumatics system. The Julian must be switched on twice after replacement. After switch-on, run through self-test as far as check list. An error message or an audible warning may be given the first time; this can be ignored.

5.4	Replace TKRAM on IRIA every 4 years Date of next replacement: ______________ Note: There are two different TKRAM versions. Replace entire TKRAM (1828142) with DIL housing (applies to about 50 units). TKRAM SMD with battery pack (1841688). Only replace battery pack. TKRAM is located on processor board of IRIA. After replacement, reset date and time in IRIA using laptop computer in service mode. See "IRIA Module Repair Instructions" for procedure.	C	☐☐☐☐☐☐☐☐☐☐
5.5	Replace nafion hose 8601238 in IRIA every 2 years. Date of next replacement: ____________ Note: IRIA units with Dräger water trap without optical filling level indicator are equipped with one nafion hose. IRIA units with water trap with optical filling level indicator are equipped with two nafion hoses. In these IRIA units the nafion hose in front of the copper restrictor might be missing. If yes, retrofit the missing nafion hose.	C	☐☐☐☐☐☐☐☐☐☐

6.	Replacing pressure regulators and diaphragms		
6.1 *	Replace ventilator low-pressure regulator, 8409199, every 6 years Additionally required parts: O-ring, large, M 23154 O-ring, small, D 19080 Date of next replacement: ______________ If the pressure regulator is not replaced, proceed with test item 7. "Gas type test, pipeline operation". Note: The pressure regulator is located next to the PEEP valve. Remove the cover from the pneumatics and fold the ventilation unit down. Pressure regulator setting after replacement:	C	☐☐☐☐☐☐☐☐☐☐

Switch on Julian and supply with pipeline gas. Acknowledge checklist. Allow self-test to run up to test step 16. Start service mode after test step 16.



Press these keys simultaneously to start service mode.

Call up menu "VentEDOS".
Call up ventilator test via "IPPV" key.
Set flow valve to 20.00 L/min.
Flow correction off.
MV 3 set to "man".

Pressure display
Write down P_{vor} at ambient pressure. V
MV 2 set to "open".

Using the pressure regulator, set the pressure rise of P_{vor} to 1800 ± 50 mbar in relation to ambient pressure.

MV 2 set to "close".
MV 2 set to "open".
The pressure rise P_{vor} should be 1800 ± 100 mbar in relation to ambient pressure. V
Julian remains in service mode.
MV 2 set to "close".
Reassemble the ventilator.

6.2 Replace diaphragms 8411129 (3 x) in pipeline inlets of pressure regulators every 6 years (US version only).

Date of next replacement: ______________ C

Adjust pressure regulator according to test item 8.3.1

6.3 Replace diaphragms 84 11 129 on pressure regulator for safety flow control device every 6 years (applies only to units with safety O2 control valve).

Date of next replacement: ______________ C

Adjustment procedure after replacement:

Connect digital pressure gauge (pressure gauge 7910724 with angle connector 7910091 or pressure gauge 7901843 with adapter 7901444) to outlet of pressure regulator.
Connect system to O_2 pipeline.
Adjust a pressure of 2.1 ± 0.2 bar.
Disconnect system from O_2 pipeline.
Remove gauge and reconnect fitting.

---

7. Gas type test, pipeline operation

Note: Pipeline pressure gauge testing does not apply to US version. This test certificate contains a separate test procedure covering the digital pressure displays used in the US version.

Connect system to pipeline. Switch on Julian, acknowledge check list and call up service mode on completion of self-test step 16.
Refer to test item 6.1 for service mode call-up.
Call up menu "SpO2/VentEDOS". Call up EDOS test via "Man/Spont" key

Disconnect system from pipeline.
V7 set to "open"
Pipeline valves "ZV AIR", "ZV N_2O" and "ZV O_2" set to "open"
If P_{tank} = ambient pressure ± 100 mbar, then close V7 and pipeline valves.

7.1 O_2 pipeline

Testing:
All gas supplies are depressurized.
Connect system to O_2 pipeline.
O_2 pressure gauge (for the US version the 7 segment display) indicates pipeline pressure. O

Call up "SpO2/VentEDOS" menu using "Man/Spont" key.

Use rotary knob to select menu item "Service Test".

Perform service test 7 "V3 (O2) Test".

Result MA0 0 0 2
SV 0 0 0 0 O

Perform service test 8 "V3 (AIR) Test".

Result MA 0 0 4 0
SV 0 0 0 0 O

Perform service test 9 "V3 (N2O) Test".

Result MA 0 0 4 0
SV 0 0 0 0 O

7.2 External O_2 flowmeter tube (optional) gas-type test

Connect system to O_2 pipeline only.
N_2O and AIR pipeline inlets are depressurized.

Open flow control valve of external O_2 flowmeter tube.

Float of flowmeter tube should rise. Close flow control valve. O

7.3 N_2O pipeline

Testing:
Connect system to N_2O pipeline.
N_2O pressure gauge (for the US version the 7 segment display) indicates pipeline pressure. O

Perform service test 9 "V3 (N2O) Test".

Result MA 0 0 0 2
SV 0 0 0 0 O

Perform service test 8 "V3 (AIR) Test".

Result MA 0 0 4 0
SV 0 0 0 0 O

7.4 AIR pipeline

Testing:
Connect system to AIR pipeline.
AIR pressure gauge (for the US version the 7 segment display) indicates pipeline pressure. O

Perform service test 8 "V3 (AIR) Test".

Result MA 0 0 0 2
SV 0 0 0 0 O

8. HP gas type test
(if HP conversion kit fitted)

Julian is in the service mode menu "EDOS Test".

Disconnect system from pipeline.
V7 set to "open".
Pipeline valves "ZV AIR", "ZV N2O" and "ZV O2" set to "open".
If P_{tank} = ambient pressure ± 100 mbar
V7 and pipeline valves set to "close".

8.1 O_2 cylinder supply

Testing:
All gas supplies are depressurized.
Open O_2 cylinder.

Call up "SpO2/VentEDOS" menu using "Man/Spont" key.

Use rotary knob to select menu item "Service Test".

Perform service test 7 "V3 (O2) Test".

Result MA0 0 0 2
SV 0 0 0 0 O

Perform service test 8 "V3 (AIR) Test".

Result MA 0 0 4 0
SV 0 0 0 0 O

Perform service test 9 "V3 (N2O) Test".

Result MA 0 0 4 0
SV 0 0 0 0 O

8.2 N_2O cylinder supply

Testing:
Open N_2O cylinder.

Perform service test 9 "V3 (N2O) Test".

Result MA 0 0 0 2
SV 0 0 0 0 O

Perform service test 8 "V3 (AIR) Test".

Result MA 0 0 4 0
SV 0 0 0 0 O

Close O_2 and N_2O cylinders.

8.3 Checking gas inlet block of the US version

Connect O_2, AIR, N_2O pipeline inlets through HP cylinder to test pressure regulator (DIN connector item no. 7901482 or, PIN indexed connector item no. 7910342), reducer (item no. 7900044), connector 1 (item no. 7901497), and gas distributor (german item no. 7901495 or, international item no. 7910341). Build up a test pressure of 5 bar.
Julian is in the service mode menu "EDOS Test".

8.3.1 Checking pressure regulators on gas inlet block

Connect one end of PE-hose, 2.7 mm, (1194925) to connector of V7 outlet (on rear panel of Julian). Connect other end of PE-hose to digital pressure gauge (pressure gauge, item no. 7910724, and angle connector, item no. 7910091, or pressure gauge, item no. 7901843, and adapter, item no. 7901444).
Set V7 to "open".
Set pipeline valve "ZV AIR" to "open".
If HP cylinders are connected, make sure they are closed.
Pressure gauge should show 3.5 ±0.3 bar. V
Set pipeline valve "ZV Air" to "close".
Adjust V10 to 12 L/min.
Wait until the digital pressure gauge decreases to zero.
Adjust V10 to 0 L/min.
Set pipeline valve "ZV O_2" to "open".
Pressure gauge should show 3.5 ±0.3 bar. V
Disconnect system from O_2 pipeline.
Adjust V10 to 12 L/min.
The digital display of the O2 pipeline pressure on Julian's front panel should decrease to zero.
The audible "O_2 shortage" warning should sound. O
Set pipeline valve "ZV O_2" to "close".
Adjust V10 to 0 L/min.
Re-connect system to O_2 pipeline.
Set pipeline valve "ZV N_2O" to "open".
Pressure gauge should show 3.5 ±0.3 bar. V
Set pipeline valve "ZV N_2O" to "close".
Adjust V10 to 12 L/min.

8.3.2 Switchover to O_2 cylinder supply (only if HP conversion kit available).

For test set-up, see test item 8.3.1.
Disconnect system from pipeline.
Open O_2 cylinder.
Cylinder pressure is shown on Julian's front panel. O
Adjust V10 to 12 L/min.
Set V7 to "open".
Set pipeline valve "ZV O_2" to "open".
Set pipeline valves "ZV Air" and "ZV N_2O" to "close".
The digital pressure gauge should show a pressure of 2.7 to 3.8 bar. O
Disconnect O_2 HP sensor connector from rear panel.
O_2 HP display on front panel should be zero. O
Digital pressure gauge display should slowly decrease to zero. O
Close O_2 cylinder.
Reconnect O_2 HP sensor connector to rear panel.

8.3.3 Switchover to N_2O cylinder supply (only if HP conversion kit available).

For test set-up, see test item 8.3.1.
Disconnect system from pipeline.
Open N_2O cylinder.
Cylinder pressure is shown on Julian's front panel. O
Adjust V10 to 12 L/min.
Set V7 to "open".
Set pipeline valve "ZV N_2O" to "open".
Set pipeline valves "ZV Air" and "ZV O_2" to "close".
The digital pressure gauge should show a pressure of 2.7 to 3.8 bar. O
Disconnect N_2O HP sensor connector from rear panel.
N_2O HP display on front panel should be zero. O
Digital pressure gauge display should slowly decrease to zero. O
Close N_2O cylinder.
Reconnect N_2O HP sensor connector to rear panel.
Disconnect pressure gauge from V7 outlet.

9. High-pressure and medium-pressure leak tests

Note: Tests with test pressure regulators and gas distributor require pipeline hoses with pipeline plug-in connectors. Wall-mounted and ceiling-mounted units may have pipeline hoses which have NIST connectors on both ends. However, the following additional pipeline hoses are required as test items:
O2 hose, 1.5 m, pipeline plug-in connector on O2 NIST connector, M 34401.
N2O hose, 1.5 m, pipeline plug-in connector on N2O NIST connector, M 34404.
AIR hose, 1.5 m, pipeline plug-in connector on AIR NIST connector, M 34407.

Julian is in the service mode menu "EDOS Test".

Adjust V10 to 0 L/min.
Depending on system version:
Set V27 and V28 to "close", or:
Set safety flow control valve to "close".
Set pipeline valves ZV AIR, ZV N_2O and ZV O_2 to "close"
Set V7 to "open".
Call up ventilator test using "IPPV" key.
Set heater to "off".
Set MV 2 to "close".
Set MV 3 to "man".
Call up EDOS test using "Man/Spont" key.

9.1 O_2, N_2O cylinder supply
(if HP accessory set fitted)

Testing:
Connect and open O_2, N_2O cylinders.
Pressure gauges indicate cylinder pressure of

> 80 bar for O_2	C										
> 45 bar for N_2O	C										

Unscrew pipeline hoses.
Close cylinders.

Test specification:
Cylinder pressure displayed may not decrease by more than 10 bar within 2 minutes.

2 minutes.	L										

Set pipeline valves "ZV N_2O" and "ZV O_2" to "open" and reduce pipeline pressure.

Close pipeline valves "ZV N_2O" and "ZV O_2"

9.2 O_2, AIR, N_2O pipeline supply

Testing:
If applicable, unscrew HP conversion kit from connections of gas inlet block.
Build up O_2, AIR and N_2O test pressure of 5 bar via HP cylinder, test pressure reducer, and gas distributor (for test equipment item nos., see test item 8.3 of TC).

Pipeline valves are closed.

Pipeline pressure gauges of Julian (or digital displays in the US version) indicate test pressure with tolerance of ±0.5 bar.
Close test cylinder. O

Test specification:
HP pressure displayed (HP gauge of test cylinder) may not decrease by more than 10 bar within 2 minutes. L

Set pipeline valves "ZV AIR", "ZV N_2O" and "ZV O_2" to "open" and reduce pipeline pressure.
Pipeline valves set to "close"

9.3 Medium-pressure and check-valve leak test

For test set-up, see test item 9.2.

Set test pressure of 2 bar.
Set V7 to "close".
V10 = 0.0 L/min.
Pipeline valves ZV AIR, ZV N_2O, and ZV O_2 set to "open".

Disconnect/unscrew O_2 and N_2O pipeline connectors.
Close test cylinder.

Test specification:
HP pressure displayed (HP gauge of test cylinder) must not decrease by more than 10 bar within 2 minutes. L

Connect O_2 and N_2O pipeline connectors.

Do not change test set-up.

10. Testing the UPS (uninterruptible power supply)

In the event of power failure, Julian is powered from the UPS.
This test checks the capacity of the rechargeable batteries. The rechargeable batteries should be fully charged.

Make sure Julian is switched on and in the service mode. Service mode was accessed after test item 16.

Unplug Julian's power cord from AC outlet. Start stopwatch.

Julian should be powered from the UPS for 30 minutes. O

After completion of UPS test, plug Julian's power cord into AC outlet.

Note:
The following test steps can be carried out while checking the UPS function. If Julian is switched off, it can only be switched on again after plugging its power cord into the AC outlet.

---

11. Checking fresh-gas flow and performing leak test on fresh-gas circuit

Note:
Julian always assumes that the gas type used for flow testing is O_2. Do not use another type of gas.

Connect O_2 pipeline supply to test cylinder, test pressure regulator, and gas distributor.

Julian in service mode menu "EDOS Test"

Note:
Access the service mode only after test item 16. Otherwise excessive deviations may occur in testing of fresh gas flow.

Set pipeline valves "ZV AIR", "ZV N_2O" to "close".
Set pipeline valve "ZV O_2" to "open"

11.1 Checking fresh-gas flow

Disconnect the measured gas return hose (if available) at the back of the device and seal off the lower connector.

Note: When Julian is used in higher altitudes, its flow valve V10 delivers a mass flow. The volume in higher altitudes increases according to the following equation:

$V = V_{10target} * 1013\ mbar / P_U$

Where P_U is the current ambient pressure. It can be determined using the IRIA pressure sensor while the suction pump is switched off.

Call up ventilator test via "IPPV" key.

MV 2 set to "close".
MV 3 set to "man".
MV 6 set to "int".
Call up EDOS test via "Man/Spont" key.

Pull out breathing system.
Connect flowmeter block (7901161) via suction tubing (M 25780) to pneumatic interface (2nd connection from left).

Set test pressure to approx. 1.5 bar

Check following flow values with V10:

Desired	Actual	
0.5 L/min	0.5 ± 0.05 L/min	V
5 L/min	5 ± 0.5 L/min	V
10 L/min	10 ± 1 L/min	V

Set V10 to 0 L/min.

11.2 Leak test, fresh-gas arm
Test set-up as in test item 11.1.
Remove vaporizers.

Note:
Leak test with vaporizers fitted is performed as part of the Julian self-test.

Instead of flowmeter, connect pressure gauge (7901515) to pneumatic interface (2nd connection from left).

Caution: Do not admit too much pressure to the pressure gauge.

Set V10 to 0.1 L/min.

Pressure > 100 mbar is built up. O
Set V10 to 0 L/min.

11.2.1 A-cone leak test and A-cone safety valve check (A-cone optional)

Test set-up as in test item 11.2.

Use "IPPV" key to switch to ventilator test.
Switch MV 6 to "ext.".
Use "Man/Spont" key to switch to EDOS test.

Connect connecting sleeve (M13506), silicone hose (1197851), and pressure gauge (7901515) to A-cone.
Set V10 to 0.1 L/min.
Pressure > 60 mbar is built up. O
Set V10 to 6 L/min.
Safety valve opens at between 80 and 120 mbar. O
Set V10 to 0 L/min.
Switch MV 6 to "int.".

11.3 Checking safety O_2

Connect fresh-gas outlet (pneumatic interface, 2nd connection from left) to flowmeter block 7901161.

Disconnect O_2 pipeline connection from HP test cylinder and connect to pipeline.

Pipeline pressure > 2.7 bar

11.3.1 Safety O_2 with valves V27 and V28

While in the service mode "EDOS Test", set valves V27 and V28 to "open".

Flow = 3.5 to 8 L/min O
Set V27 and V28 to "close"

Flow = 0 to 50 mL/min O

11.3.2 Safety O_2 with flow control valve (optional)

Set flow control valve to 0 L/min.
Flow = 0 L/min. O

While in the service mode menu "EDOS Test", check the safety O_2 feedback. It should be "close" "close". O

Set flow control valve to 4 L/min.
Flow = 4 L/min ±1.2 L/min. O

Safety O_2 feedback: "open" "open". O

Set flow control valve to 12 L/min.
Flow = 12 L/min ±3.6 L/min. O

Set flow control valve to 0 L/min.

11.4 Checking O_2 flush

Connect fresh-gas outlet to flowmeter (7900718).
Press O_2 flush knob.

Flow = 35 + 10 L/min. V

Release O_2 flush knob.
Flush knob does not catch. O

If available, connect sampling gas return line.

Close the pipeline valve.

The same test set-up is used in the next test item.

---

12. Checking driving flow and switching of driving gas

Julian in service-mode menu "EDOS Test".
Establish AIR and O_2 pipeline supplies.
Close pipeline valves.
Call up "Ventilator Test" menu.

Connect flowmeter (7900718) to pneumatic interface of breathing system (center connector).
Flow correction set to "on".
MV 2 set to "close".
MV 3 set to "man".
MV 5 set to "AIR".

12.1 Checking driving flow

Set flow valve to 20 L/min.

Note pressure display P_{vor} at ambient pressure V

MV 2 set to "open".

$\dot{V}$ = 20 ± 2 L/min. V

The pressure rise of P_{vor} = 1.8 ± 0.1 bar in relation to ambient pressure V

Set flow valve to 75 L/min.

$\dot{V}$ = 75 ± 7.5 L/min. V

The pressure rise of P_{vor} = 1.8 ± 0.3 bar in relation to ambient pressure V

Set flow valve to approx. 20 L/min.

12.2 Checking driving gas switching

Interrupt AIR pipeline supply.
$\dot{V}$ = 0 L/min. O

MV 5 set to "O_2".
$\dot{V}$ = 20 ± 2 L/min. O

MV 5 set to "AIR".
Disconnect pipeline supplies.

MV2 set to "close".

13. Checking breathing-system heater

Julian is in service mode menu "Ventilator Test".
Breathing system is not attached.
Heater is set to "off".

Heater contact surface at ambient temperature. O
Set heating to "on".
Temperature increases slowly. O
Set heating to "off".

---

14. Checking pressure sensors and safety valve

Julian is in the service mode.

Breathing system is disconnected.

14.1 Zero point of pressure sensors

Note:
In the US version, P_{air} is not tested in this test item. Testing has already been carried out under test item 9.2. In the US version, P_{air} is a differential pressure sensor to the value of which 1013 mbar have been added.

Call up service menu "pressure".
Use key "Cal press" to calibrate sensor P_{awm}.
Error indicates 0 - no error. O

Exit from menu "pressure" and call up "SpO2/ VentEDOS".
Call up EDOS test via "Man/Spont" key.

Disconnect pipeline supply.
ZV AIR, ZV N_2O and ZV O_2 valves set to "open".

V7 set to "open".

Note P_{air} pressure value.
(Does not apply to US version). V

Note P_{tank} pressure value. V

Note P_{sys} pressure value. V

Note P_{vor} pressure value. V

The pressure values for P_{tank} and P_{sys} may differ by max. 50 mbar.

The pressure values for P_{tank} and P_{vor} as well as P_{tank} and P_{air} (does not apply to US version) may differ by max. 100 mbar. O

P_{awv} = 0 ± 2 mbar O

P_{awm} = 0 ± 2 mbar O

Close pipeline valves and V7.

14.2 Checking P_{awv}, P_{awm} and safety valve

Re-establish pipeline supply.

Mount breathing system and seal off Y-piece.

Call up "SpO2/VentEDOS" menu.

Use control knob to select menu item "Service Test".

Select service test 23 "PSI Safety Pressure Valve Test", start test and switch immediately to "EDOS Test" menu using the "Man./Spont" key.

Compare pressure values for P_{awm} and P_{awv} when flow noise of open Psi safety valve is audible.
Pressure values must not deviate by more than 4 mbar. O

Use "Man/Spont" key to return to "SpO2/VentEDOS" menu.

Psi pressure display = 75 to 90 mbar. V

If Psi is outside the above range, calibrate safety valve to Psi pressure 80 - 84 mbar (see "Adjusting the Safety Valve" in the Repair Instructions).

Psi pressure display = 80 to 84 mbar.

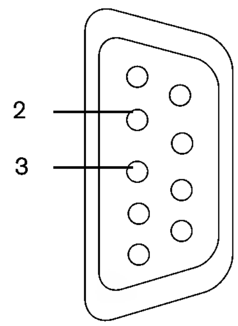
15. Annual checking of CIO PCB interfaces

Date of next check: ____________________

Julian in service-mode menu "Service 2".

CIO PCB interface connections.	C										

15.1 COM 1 - COM 3 interface test

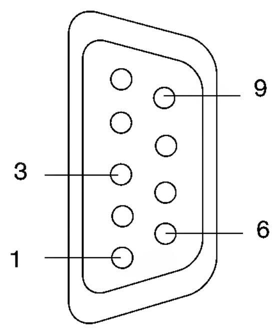


Short circuit pins 2 and 3 in each case on back wall at serial interfaces.

Press "Serial 1 Check". Testing is followed by "OK".	O										
Press "Serial 2 Check". Testing is followed by "OK".	O										
Press "Serial 3 Check" Testing is followed by "OK".	O										

Remove shorting links from interfaces.

15.2 Checking analog interfaces



Press "Analog Out Check".

Measured voltage corresponds to displayed voltage ±10 mV.

Analog interface pins 1, 3.	O										
Analog interface pins 1, 6.	O										
Analog interface pins 1, 9.	O										

16. Operating hours
(software version 1.04 or later)

Julian is in service mode menu "Service 2".
Note operating hours.

Total hours: V

EDOS hours: V

Vent hours: V

---

17. Checking flow measurement

Julian is in the service-mode menu "Flow/ Temp".
Breathing system not fitted.

Instead of flow sensor, insert dummy MV sensor 7900777 in sensor mount using adapter 7910454.

Note:
If flow measurement does not function, turn the adapter 180° at the device.

Note flow correction factor and then set to 0. V

Spirolog tester set to switch position 15, ALT
Simultaneously press "CAL" key on dummy and "Flow >0<" on Julian.
"UR15" value: 1010 ± 5. O
Release "CAL" key.

Wait until display stabilizes.

MV	= (15 ± 1.2) L	V
Vt	= (0.5 ± 0.04) L	V
f	= (30 ± 2) $min.^{-1}$	V

Reset flow correction factor to customer setting.

Disconnect dummy MV sensor and adapter.

18. Checking temperature measurement

Julian is in service mode menu "Flow/Temp".

Temperature socket on Measured Value PCB. C

Connect temperature-sensor dummy (7900405).
Test switch setting: 40 °C
Temp display = 40 ± 1 °C V
Remove sensor dummy.
Display: Temp = – °C O

Error = 2 O

Connect temperature sensor, if available.

---

19. Checking SpO_2 measurement (optional)

Julian is in service mode menu "SpO2/ VentEDOS".

SpO_2 sensor socket. C

19.1 Connect Nellcor pulse oximeter tester or pocket tester to SpO_2 socket.

Display on screen:

Pocket tester:
"SpO_2" 81 ± 1 O

"Pulse" 40 ± 1 O

With above tolerances.

Pulse oximeter tester SRC 2:
Rate = 38
Light = High
Modulation = Low
RCAL/mode = LOCAL/RCAL 63

Display: "SpO_2" 81 ± O

"Pulse" 38 ±1 O

19.2 Sensor test

Remove SpO_2 tester.

Connect finger clip.

Measure your own oxygen saturation.

Reading: > 90% O

Disconnect finger-clip sensor from SpO_2 socket.

20. Checking IRIA and suction pump

Julian is in service mode menu "IRIA"

Switch on IRINA to warm up if it is used to perform the anesthetic gas measurement.

Note:
Do not calibrate the O_2 sensor or the IRIA while performing the flow rate test.

20.1 Flow rate test

Connect the top port of the flowmeter block 7901161 to the water trap by using the silicone hose 1197851.
Set the flow rate to "Low" in the service mode menu.
Flow = 60 ± 20 mL/min. V

Set flow rate to "high".
Flow = 200 ± 30 mL/min. V

20.2 Checking pump capacity and pressure sensor IRIA
Set flow rate to "off".
Compare pressure displayed at digital barometer (7900217) in the IRIA menu under "pressure" with ambient pressure.

Difference < 20 mbar O

Connect digital barometer without sampling tube to water trap. Set flow rate to "High".
Pressure must decrease within 30 s to at least 240 mbar below ambient pressure. O

On reaching lowest pressure, difference between barometer pressure and displayed pressure must be < 20 mbar and general state indicated must be "40" O

Note: Check for leaks at the IRIA if large deviations between the barometer pressure and the IRIA occur.

Remove digital barometer

20.3 Checking water separator

Set flow rate to "High".
Remove sampling tube.
Record the pressure displayed in the IRIA menu under "pressure". V

Remove water separator.
Pressure must not increase by more than 70 mbar O
Install water separator.

20.4 Checking IRIA (optical bench) in ambient air

Julian is in service-mode menu "IRIA".
The following measurement can only be performed after reaching full accuracy (approx. 10 minutes after power-on).

Press zeroing key →0← on Julian.

The following concentrations should be displayed in ambient air:

Anesthetic gas : 0.0 +0.2% by vol. V

CO_2 : 0.0 +0.2% by vol. V

N_2O : 0 +2.5% by vol. V

20.5 Checking display accuracy with IRINA and calibration gas canister Minican (8290271)

Note:
Continue with test item 20.6 if test gas 7910345 with 1% desflurane is used for testing.

20.5.1 CO_2/N_2O display accuracy

Set "O_2 digital" value on Julian to value of calibration gas canister. To do so, press and set rotary knob.

Use soft key "Curve select" to switch lower curve to N_2O.

Connect calibration gas canister to sampling tube and open canister. Wait until curve and digital values have stabilized.

Notice: The test gas cylinders are provided with labels which show the actual concentrations.

Take CO_2 value reading from screen.
CO_2 value may differ from cal. gas by 0.2% by vol. V
(CO_2 concentration = 5%)

Take N_2O value reading from screen.
N_2O value may differ from cal. gas by 2.5% by vol. V
(N_2O concentration = 65%)

Close the canister.

20.5.2 Display accuracy and anesthetic gas recognition

Equip Julian with Vapor anesthetic vaporizer.

Exit from service menu "IRIA" and call up "SpO2/VentEDOS".

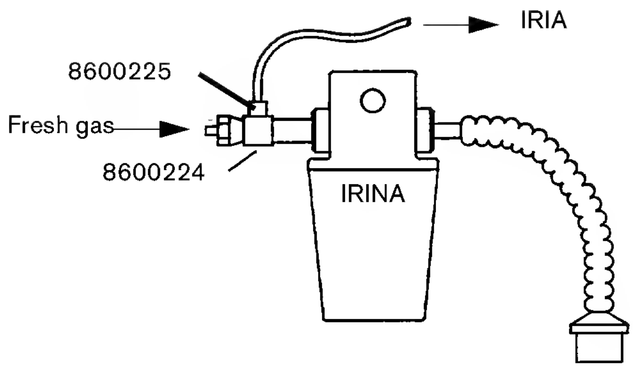
Use "IPPV" key to call up ventilator test.
MV 2 set to "close".
MV 3 set to "man".
Use "Man/Spont" key to call up EDOS test.

ZV AIR at "open", and set V10 to 2 L/min.
Connect system to AIR pipeline.
Call up service menu "IRIA".
Remove breathing system.

Connect IRINA sensor to T-piece of Julian and insert diameter 6 catheter connector in T-piece.

Connect catheter connector to fresh-gas outlet (2nd connection from left) on Julian.

Connect suction system or anesthetic-gas filter to other end of IRINA sensor.



Set "O_2 digital" value on Julian to 21%. Select corresponding anesthetic gas on IRINA.

Connect sampling tube of Julian.

Set Vapor handwheel to 3% (6% for desflurane) and wait about 1 minute.
Julian should recognize the correct anesthetic gas. O

Read off IRINA display and compare to Julian.
Difference < 0.4% by vol. for desflurane. V

Difference < 0.2% by vol. for sevoflurane, isoflurane, halothane and enflurane. V

Set Vapor handwheel to max. (12% for desflurane) and wait about 1 minute.
Check anesthetic gas identification. O

Read off IRINA display and compare to Julian.
Difference < 1.2% by vol. for desflurane. V

Difference < 0.8% by vol. for sevoflurane, isoflurane, halothane and enflurane V

Set vaporizer to zero (0%).

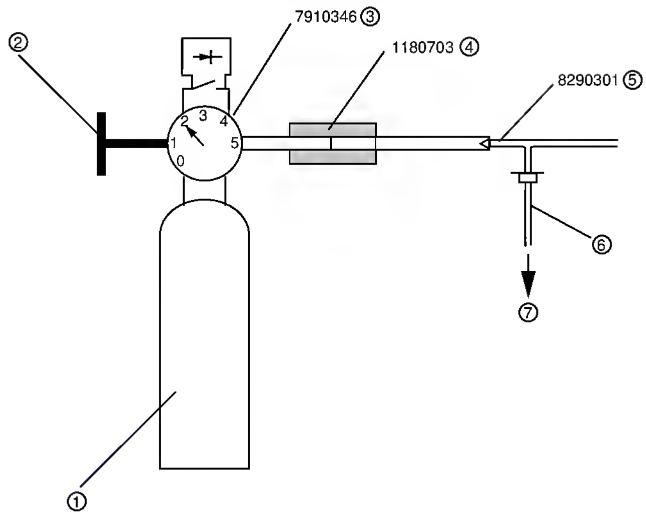
Close ZV AIR in menu "EDOS Test" and set V10 to 0 L/min.

Use IRINA test set-up for O_2 sensor test.

20.6 Checking the display accuracy with test gas 7910345 (1% desflurane, 5% CO_2, 60% N_2O, residual O_2)

Note:
You can skip this test item if you have already checked the display accuracy under test item 20.5.

Test set-up:



Legend:

1	Test gas 7910345
2	Stop valve
3	Pressure regulator 7910346
4	Tube 1180703
5	Calibration adapter 8290301
6	IRIA sampling line
7	To IRIA

Julian is in service mode menu "IRIA". The following measurement can only be performed after reaching full accuracy (approx. 10 minutes after power-on).

Press zeroing key on Julian.

Connect IRIA sampling line to calibration adapter.

Set IRIA pump flow to "High". In the IRIA service mode, use the control knob to set "O_2 digital" to the O_2 value of the test gas canister.

Set the pressure regulator handwheel to minimum. Open the stop valve.

Using the pressure regulator handwheel, slowly increase the pressure until you can hear the calibration gas escaping from the calibration adapter.

Notice:
For prolonged testing procedures connect the outlet of the calibration adapter to an anesthetic gas scavenging system or to a anesthetic filter.

Note:
The test gas canisters are supplied with a report. This report contains information about the actual concentration of each canister. Please consider this should you find any deviations from the concentrations given on the canister label.

Julian should detect desflurane.. O

The desflurane value may deviate from the test gas by 0.2% by vol. V

The CO_2 value may deviate from the test gas by 0.2% by vol. V

The N_2O value may deviate from the test gas by 2.5% by vol. V

Set the pressure regulator to minimum and close the handwheel.

Remove the test set-up.

---

21. Checking O_2 measurement

Julian is in the service mode menu "O_2/ pressure".

Establish O_2 and AIR pipeline supply. Sampling line in ambient air.

Sensor voltage is 10 to 21 mV. O

Remove O_2 sensor capsule (6850930).

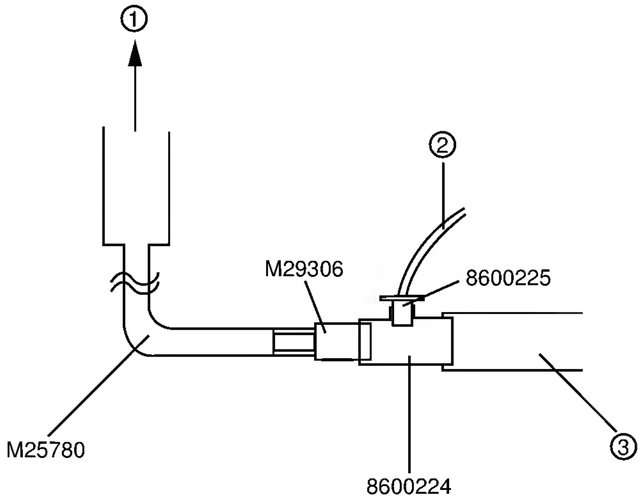
* Replace O-ring D 15330 if necessary. C

Spring contact. C O

Mount O_2 sensor capsule.

21.1 100% calibration of O_2 measurement

Use IRINA test set-up or the following test set-up:



Legend

1	Julian fresh-gas outlet, 2nd connection from left
2	Sampling line to IRIA
3	Any type of silicone tube; length: approx. 20 cm

Connect the sampling tube.

Access service menu "VentEDOS" and call up EDOS test via "Man/Spont" key.

Depending on system version:
V27 and V28 set to "open" or safety flow control valve set to approx. 2 L/min.
Call up service menu "O_2/pressure".
Press "Cal 100%" key.

"FiO2 CAL %" should appear during calibration. O

Calibration is completed after max. 4 min. O

FiO_2 = 100 ±3% O

Switch V27 and V28 to "close" or close safety flow control valve in service menu "EDOS Test" and call up "O_2/pressure" again.

Sampling gas tube in ambient air for approx. 2 minutes. FiO_2 measured value on completion of this period is 18 - 24%. O

* If not, replace sensor capsule.
Press "CAL 21%" key.

---

22. Safety checks
Julian is switched off. Power cord is disconnected from AC outlet.

22.1 Power cord C

22.2 Fuse links, convenience receptacles (only for floor unit)

Two fuses per convenience receptacle
Rating as per label C

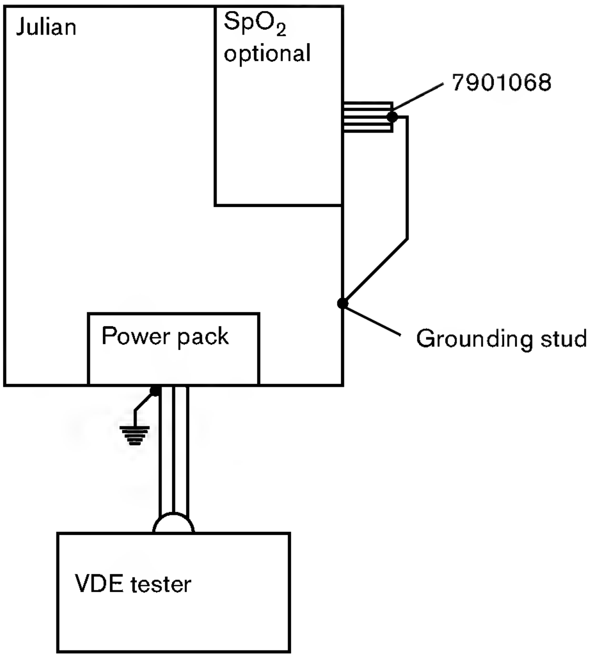
22.3 Protective conductor test as per VDE 751

Note regarding wall-mounted and ceiling-mounted systems with permanently wired power cable:
Perform protective conductor measurement between grounded metal parts of the pendant head/wall mount and Julian.
Connect test cable for contact resistance 7900882 to VDE tester. The black conductor of this cable is wired to the ground contact of the grounding plug.
Connect the black conductor of the test cable to the metal parts of the pendant head/wall mount. Use the test probe of the VDE tester to measure the resistance to the metal parts of Julian. Enter protective conductor contact resistance into test certificate.

Take measurements at following components:
Power-pack earthing stud and earthing stud of ancillary sockets, back-wall screws, gas inlet block, breathing-system rail (pull out breathing system), vaporizer plug-in system, vertical rail sections on left and right of Julian housing.

Test specification: $R \leq 0.3\ \Omega$ for systems with permanently wired power cable
or
$R \leq 0.2\ \Omega$ for systems with inlet connector for non-heating devices. O

22.4 Equivalent apparatus leakage current



Note regarding wall-mounted and ceiling-mounted systems with permanently wired power cable:
The permanently wired power cable of wall-mounted or ceiling-mounted systems are, on the system end, connected to the power supply unit via an inlet connector for non-heating devices. Disconnect the inlet connector for non-heating devices of the permanently wired power cable from Julian. Connect Julian and VDE tester to "Ceiling power supply" (8601590) and carry out equivalent device leakage current.
Disconnect power plugs of ancillary equipment from convenience receptacles of Julian.

Short circuit inputs of SpO2 module (optional) with test connector 7901068 from Nellcor test set 7901069 and connect to metal parts of Julian.
Julian must not be connected to protective conductor as otherwise leakage current to be measured will flow off to protective conductor.

Connect VDE portable test set to mains connector of Julian

Switch on Julian

Follow-up measurements may exceed first-measured value by max. 50% and must at the same time be $\leq$ 750 µA.

First-measured value

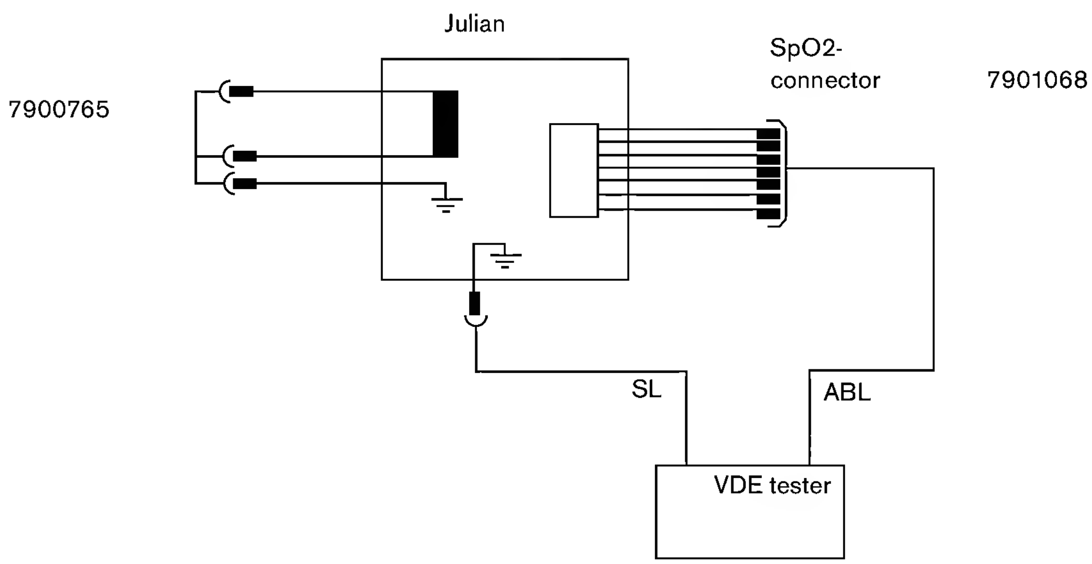
$I_{leak} \leq 750$ µA

Note:
Always transfer first-measured value to new TC.

Test value: Actual value $\leq$ 750 µA V

Switch off Julian.

22.5 Equivalent patient leakage current (SpO_2 module optional)



Connect Julian power cord to shorting plug 7900765.

Warning:
Measurement voltage is 242 V (AC).

Connect Julian SpO_2 sensor connector to test connector 7901068.
Attach ABL connection of portable test set to test connector. Connect grounding point to SL socket of test set

All follow-up measurements may exceed first-measured value in TC by max. 50% and must at the same time be $\leq$ 50 µA.

If first-measured values are < 20 µA, follow-up measurements may differ by up to 10 µA.

First-measured value µA

Note:
Always transfer first-measured value to new TC.

Test value: $I_{leak} \leq 50$ µA V

Remove test set-up

---

23. Julian power-on test and ventilation mode function

23.1 Power-on test/self-test

23.1.1 Digital displays self-test (US version)

Make sure Julian is switched off.
Disconnect power cord from AC outlet.
Wait 5 seconds.
Connect power cord into AC outlet.
Digital displays carry out a self-test.
Each segment should be activated. O

23.1.2 Fully assemble Julian.
Fit breathing system checked according to TC.
Switch on Julian.
Check that all LEDs are activated. O

Check that the audible alarm sounds. O

The software version of Julian is displayed.

Enter software version at start of TC. O

Acknowledge check list and allow self-test to complete.

Leakage rate $\leq$ 85 mL/min. V

Check that self-test is completed successfully. O

Transfer test value and error-free self-test to TC 5132.010

23.2 Functional test of ventilation mode

Julian set to standby.
Call up service mode.
Call up Flow/Temp menu.
Disconnect expiratory hose at breathing system.
Seal socket and press "Flow >0<" key.

UR15 = 1010 ±5 O

Connect hose and exit from service mode by pressing "Exit" key.

Julian should be in standby.

Fresh-gas setting:
Press AIR key and confirm.
Set O_2 concentration to 25%.

23.2.1 Manual ventilation, APL valve

Press "Man/Spont" key and confirm with control knob.

Julian should switch to Man/Spont mode. O

Remove manual breathing bag and connect connecting sleeve (M13506), silicone tube (1197851), and pressure gauge (7901515).

Set fresh-gas flow to 10 L/min.

Set following values with APL valve and read off on pressure gauge:

Setting:	Measured value	
10 mbar	7 to 13 mbar	O
30 mbar	25 to 35 mbar	O
70 mbar	60 to 80 mbar	O

Set APL valve to 30 mbar.
Set flow to 3 L/min.
Connect manual breathing bag.

Connect test thorax.

Perform manual ventilation. O

23.2.2 Spontaneous breathing

Set APL valve to "Spont".
Check that spontaneous breathing can be carried out with test thorax. O
Set APL valve to "Man".

23.2.3 PCV ventilation

Press "PCV" key and confirm with control knob.

Check that Julian switches to "PCV" mode. O

Ventilation parameter settings:

Pmax	: 20 mbar
Insp. flow	: 30 L/min.
Freq.	: 6 ^{1}/min
PEEP	: 0 mbar

Use key to select data screen.

Test value:

Plat. = 20 ± 3 mbar V

PEEP -2 mbar to +4 mbar V

23.2.4 IPPV ventilation

Note regarding Julian with software version 1.04 or earlier:
Julian has no compliance correction. When checking flow measurement, allowance must be made for compliance of breathing system (approx. 4 mL/mbar). Therefore, use a test thorax with the greatest possible compliance (approx. 50 mL/mbar). You can also use the manual breathing bag which can be removed in IPPV mode and connected as test lung to the Y-piece.

Press "IPPV" key and confirm with control knob.

Check that Julian switches to "IPPV" mode. O

Ventilation parameter settings:

P_{max}	: 60 mbar
V_T	: 800 mL
Freq.	: 10/min
T_I:T_E	: 1:1
T_{ip}:T_i	: 50
PEEP	: 10 mbar

Press O_2 flush button, in order to fill the test thorax.

Press "autoset limits" button.

Use key to select data screen.

Check following values after about 10 breaths:

PEEP display = 10 ±2 mbar V

The bellows in the bellows compartment rises by 8 ±1 graduation marks. (In the event of a fault, see repair information "Bellows does not rise".). O

For Julian with software version 1.04 or earlier:
V_T display = (0.8 L - V_{TC}) ±0.06 L V

For Julian with software version 2.0 or later:
V_T display = (0.8 L) ±0.06 L

Note regarding Julian with software version 1.04 or earlier:
V_{TC} = Loss due to breathing-system compliance.
V_{TC} = (Plat. - PEEP) 4 mL/mbar.

Transmit error-free ventilation mode to TC 5132.010.

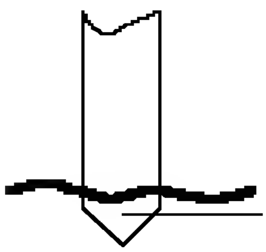
---

24. Testing water trap level detector (applies to water trap with filling level detector)

Caution:
This test may lead to damage to the IRIA due to water being sucked up. Observe test sequence carefully!

Remove water trap to avoid accidental sucking up of water.

Fill the water trap vessel 3/4 full with water. **Insert the vessel only far enough, so that the tapered end is fully submerged into the Plexiglass probe.**



Insert tapered end to this level only!

"water trap?!" is displayed in the status field of Julian.

Empty vessel, clean prism.

Connect water separator.

25. Alarm function test

Julian is in the "IPPV" operating mode.
Press " alarm limits" key.
Set upper PAW limit value to below the peak value of the pressure measurement and confirm.

PAW /↑ !!! should appear on the display. O

The red alarm LED should flash. O

The audible alarm should sound. O

Press key.

The audible alarm should stop. O

Press "autoset limits" button.

---

26. Test key function

Make sure Julian is in the "IPPV" mode.

Note:
Only those keys are checked that have not been used when carrying out the Test Certificate steps.

Press "N_2O" key and confirm.
The key LED should come on. O
Press "AIR" key and confirm.
The key LED should come on. O

Press keys in bottom softkey row twice in succession.
The respective parameters are shown in reverse video. O

Use key to select trend screen.

Press key.
Check that first screen page is shown. O
Press key and confirm.

Julian should switch to standby. O

---

27. Testing power failure alarm

Switch Julian to Man/Spont mode.
Disconnect power cord from AC outlet.
The message "Powerfail!" should appear on display within 1 minute. O
If applicable, press "Alarm Info" key.
Switch off Julian.
LED at top right of monitor should not come on. O

Switch on Julian.
Audible power failure alarm sounds for > 30 s. O
Switch off Julian.
Connect power cord into AC outlet.
LED should come on. O

---

28. Place unit at the user's disposal ready for operation.

---

29. Test certificate

Name:

Date:

Signature:

* These steps are regarded as repair work and therefore not included in the inspection service price.

---

30. Report:

Tool for replacement of Turcon rings at breathing system interface........................ 79 10 446
Socket spanner (24 mm) for NIST connections 79 10 449
Adapter for HP regulator test with hex socket G3/8“ (replaces U03315)............. 79 10 718
Adapter for HP regulator test with hex socket G3/8“... 79 01 435
Reducer for HP regulator test with hex socket G3/8“... 79 01 459
2 x adapter for HP regulator test with hex socket G3/8“ or M10*1 .... 79 01 437
PE hose, 2.7 mm.. 11 94 925
PE hose, 6 mm 12 02 618
Test pressure regulator for HP test cylinder with German DIN connector 79 01 482
Gas distributor for HP test cylinder with check valves German DIN standard....... 79 01 495
Test pressure regulator for HP test cylinder with PIN indexed connector 79 11 342
Gas distributor, international, for HP test cylinder with open outlet (to fit country-specific connectors with check valves).. 79 10 341
Reducer to adapt gas distributor to test pressure regulator 79 00 044
Connector 1 to adapt gas distributor to test pressure regulator............................. 79 01 497
Flowmeter block 0.01–14 L/min[1] 79 01 161
Flowmeter 10–120 L [1].. 79 00 718
Suction tubing for tests on pneumatic interface .... M 25 780
Pressure gauge -30/120 mbar [1] 79 01 515
Stopwatch [1]... 79 10 299
Measuring line 1 mm, kit (for COM 1-3 and analog interface test) [1]..................... 79 01 196
AMV sensor dummy... 79 00 777
AMV sensor dummy adapter.. 79 10 454
Temperature sensor dummy 79 00 405
SpO_2 pocket tester.. 79 01 069
Digital air pressure gauge for testing of IRIA pump and sensor [1] 79 00 217
IRINA 82 00 500
$CO_2/O_2/N_2O$ test gas (Minican).. 82 90 271
Flow control valve for Minican without pressure gauge, or....................................... 82 90 272
Flow control valve for Minican with pressure gauge 79 10 488
$CO_2/O_2/N_2O$ desflurane test gas (instead of test with Minican/IRINA) [1] 79 10 345
Pressure regulator for test gas 79 10 345 [1]... 79 10 346
Hose (connection between calibration adapter and pressure regulator)................ 11 80 703
Catheter connector, size 6.. M 29 306
T-piece for sampling gas suction device... 86 00 224 set of 10
Filter for T-piece.. 86 00 225 set of 20
Calibration adapter, not need if using Scott cal gas adapter.................................... 82 90 301
RS232 extension... 79 01 808
Laptop computer...
DrägerService software 9.1 or later...
VDE tester [1] 79 00 234
Short-circuit connector for power cable 79 00 765
Short-circuit connector SpO_2 .... 79 01 068
Test thorax [1] 79 01 603
Cross piece... 79 01 504
Connecting sleeve... M 13 506
Silicone hose 11 97 851
Ceiling power cable (only for ceiling/wall-mounted units with permanently wired power cable)... 86 01 590
Test cable for protective conductor contact resistance (only for ceiling/wall-mounted units with permanently wired power cable)........................... 79 00 882

[1] Or similar item which meets the specifications of the relevant test equipment.

O_2 hose, 1.5 m pipeline connector to O_2 NIST (wall/ceiling-mounted units) ....M 34 401
N_2O hose, 1.5 m pipeline connector to N_2O NIST (wall/ceiling-mounted units)..M 34 404
AIR hose, 1.5 m pipeline connector to AIR NIST (wall/ceiling-mounted units)......M 34 407
Pressure gauge, 20 bar [1] 79 10 724
Elbow connector for pressure gauge 79 10 724..79 10 091
or
Pressure gauge, 20 bar [1] 79 01 843
Adapter for pressure gauge 79 01 843...79 01 444

Pressure gauge, 300 bar (HP sensor test, only US version) 72 02 974
Copper washers (HP sensor test, only US version) D04743

Table for altitude compensation of flowmeters..7910698

Required Spare Parts (as applicable) for Julian Test Certificate

Every 6 months

Bacterial filter for sampling gas return line..84 02 868
Bacterial filter, secretion suction device ....67 23 976 set of 5

HP regulator for cylinder supply - sealing ring for cylinder connection .see spare list

Once a year

Vaporizer plug-in system O-ring ....U 04 314

Fan mats for device rear panel...86 01 169

Every 2 years

Nafion hose in IRIA module...8601238
Sintered filter of the gas connection block ....M 19 238
O-ring of gas connection block...R 31 296
Lithium battery for CIO PCB, Ventdos Controller PCB 18 35 343
Lead-gel battery for power pack ....86 01 764 set of 2

Every 4 years

TK-RAM DIL for IRIA, or 18 28 142
Battery pack, TK-RAM SMD for IRIA 18 41 688

Every 6 years

High pressure regulator - diaphragm valve with O-ring 23 12 600
Low pressure regulator for ventilator..84 09 199
O-ring, large, for 84 09 199...M 23 154
O-ring, small, for 84 09 199 ....D19080
Diaphragms (3* for US version and 1* for safety flow control valve..84 11 129

As necessary

[1] Or similar item which meets the specifications of the relevant test equipment.

Particle filter for anesthetic gas scavenging system .... M 33 294
Turcon ring for pneumatic interface .... M 33 899
O-ring for pneumatic interface .... M 33 747
Connecting hose for bronchial suction device...................................... 12 03 606
Secretion suction tube .... M 25 780
Float of the secretion suction device container cap .... M 26 007
Mica disk of the secretion suction device pressure-relief valve.......... R 17 329
Secretion container or 2M 85 594
Secretion container .... M 20 091
Sealing ring of the secretion suction device angle connector........... R 50 117 set of 10
O-ring of NIST connector .... M 30 430
O-ring of NIST connector .... E 20 264 or AF00352

Strainer .... M 19 238 set of 3
Sidestream O_2 sensor capsule 68 50 930
O-ring for sensor screw .... D 15 330
Flow sensor 84 03 735
Temperature sensor 84 05 371

Dräger

Safety and Function Test
Julian

File no.:
5132.000
Edition: 09/99

Legend:

C = Check condition

O = Check function

L = Check for leaks

V = Enter test value

N/A = Not applicable

Ventilation modes:
USA: IPPV = CMV
France: IPPV = VC
PCV = VPC

Units conversion table:
1bar = 14.504 psi
1 mbar = 1.01973 cmH_2O

1. Unit, general

1.1	**Software version of Julian** (read out later during power-on self-test).	V
1.2	**Options according to rating plate:** N/A	V
1.3	**Operating hours** (read out later in Extended Service Mode)	
	Operating hours	V
	EDOS hours	V
	Vent hours	V
1.4	**General condition**	C
	Check labelling for legibility and correct colour coding, if applicable. Stability (castors). Moving parts (writing tray, doors, hinged arm). Country-specific encoding and colour coding of pipeline hoses.	
1.4.1	Bag resuscitator	C
1.4.2	Instructions for use and log book provided (ask user).	

1.5	**System options/configurations**	
1.5.1	Serial number of breathing system cover (on APL valve).	V
1.5.2	Serial number of valve plate expiration crater.	V
1.5.3	Serial number of valve plate inspiration crater.	V
1.5.4	Serial number of respiratory gas block on PEEP valve crater.	V
1.5.5	Cylinder pressure regulators (optional) O_2	V
	N_2O	V

2.	**Replacement of wear and tear parts**	
	Notice: Before replacing the lithium battery of the CIO PCB, record the customer parameters and configurations and restore them after installing the new battery.	
2.1	Filter (1 x), 8402868, for sampling gas return line (for system with sampling gas return line only).	Replace every 6 months
2.2	Bacterial filter (1x), CH 102, of bronchial suction device	Replace every 6 months
2.3	Fan mat (3x), 8601169, on rear panel	Replace every 12 months
2.4	O-ring (4x), U04314, of Vapor plug-in system	Replace every 12 months
2.5	O-ring (3x), R31296, in pipeline connection block	Replace every 2 years
	Filter insert (3x), M19238, in pipeline connection block	Replace every 2 years
	When dismounting the NIST connectors in order to replace the filter insert, also replace the following components (applies only to first batch of 500 systems shipped until 2nd quarter of 1997):	
	O-ring (5x), M30430	Replace every 2 years
	O-ring (5x), E20264 or AF00352	Replace every 2 years
2.6	Lithium battery (1x), 1835343, on the CIO PCB	Replace every 2 years
2.7	Lithium battery (1x), 1835343, on the Ventdos Controller PCB	Replace every 2 years
2.8	Lead gel battery (1x), 8601764 (set of 2), of the power pack	Replace every 2 years
2.9	TK-RAM (1x), 1828142, in IRIA module of the Processor PCB	Replace every 4 years
	For Processor PCB with TK-RAM SMD: TK-RAM (1x), 1841688, in SMD battery pack	Replace every 4 years

2.10	Nafion hose (2x), 8601238, in IRIA module	Replace every 2 years
2.11	Low-pressure regulator, 8409199, in ventilator Also required: O-ring, large (1x), M23154 O-ring, small (1x), D19080	Replace every 6 years
2.12	Pipeline inlets pressure regulators (USA version only): Diaphragm set (3x), 8411129	Replace every 6 years
2.13	Safety O_2 pressure regulator (only systems with safety O2 control valve) Diaphragm set (1x), 8411129	Replace every 6 years
2.14	Cylinder supply high-pressure regulator (optional)	
	Sealing ring (flat packing ring for Pin-Index-connection) of cylinder connection (1x) (see parts list for part number)	Replace every 6 months
	Diaphragm valve (1x), 2312600	Replace every 6 years

3.	**Operational reliability**	
	Make sure system is completely assembled and ready for operation. Check that system is switched off and power cord unplugged.	
3.1	Check power cord	C
3.2	Check auxiliary outlet fuses	C
3.3	Protective conductor test	
3.3.1	Systems with permanently installed power cord: $R < 0.3\ \Omega$	V
3.3.2	Systems with inlet connector for non-heating devices: $R < 0.2\ \Omega$	V
3.4	Equivalent device leakage current: $I_{leak} \leq 750\ \mu A$	V
3.5	Equivalent patient leakage current SpO_2 (optional): $I_{leak} < 50\ \mu A$	V

4.	**Test items**	
4.1	AGS (Anaesthetic gas scavenging)	
	Check tubing and function. Float should move between upper and lower marking.	C

4.2 **Cylinder gas supply** (optional)

Leak test:

Disconnect pipeline connections on system end, system is switched off.
Open cylinder valves.
The high-pressure gauges on the pressure regulators (or the digital pressure displays on the front of the US version) should indicate the cylinder pressure. O
Close cylinder valves.
Check that decrease in pressure is < 10 bar within 2 minutes. L
Keep cylinders closed.

4.3 Functional check of bronchial suction device

Dismount complete bronchial suction device. Connect system to pipeline supply. Connect vacuum hose for vacuum suction. Set vacuum switch to position 1 and control valve to maximum pressure.

4.3.1 Ejector operation

Seal off suction hose. Check that -0.8 bar are reached. C

4.3.2 Vacuum suction

Seal off suction hose. Check that vacuum is generated. C

4.4 Functional check of Vapor plug-in system

Check locking mechanism and interlock system with vaporizers fitted. O

Note: Perform tests 4.5 through 4.13 in the Extended Service Mode.

Call up Extended Service Mode in power-on self-test after "Test step 16". See Appendix for description of how to access the Extended Service Mode.

Connect system to pipeline supply. Switch Julian on and access the Service Mode. Call up "Service 2", read out operating hours and enter under test step 1.3.

4.5 Functional check of the UPS (uninterruptible power supply)

Make sure the rechargeable battery is fully charged.
Unplug Julian's power cord and start stopwatch.
Check that Julian is powered from the UPS for 30 minutes. O
Reconnect Julian's power cord.

Note: While checking the UPS, you can continue with the next test steps. Once Julian is switched off, it needs to be connected to an AC outlet in order to be able to switch it on.

4.6 Function check of safety O_2

4.6.1 Safety O_2 with V27 and V28 valves

After accessing the Extended Service Mode, start immediately "EDOS test".
Set V27 and V28 to "open"
Deflate manual breathing bag shortly.
Feedback: V27 and V28 are set to "open".
Manual breathing bag inflates. O
Reset V27 and V28 to position "close".

4.6.2 Safety O_2 with safety O_2 control valve (optional)

After accessing the Extended Service Mode, start immediately "EDOS test".
Deflate manual breathing bag shortly.
Set safety O_2 control valve to 12 L/min.
Feedback: "Safety O_2:" is in position "open".
Manual breathing bag inflates. O
Close safety O_2 control valve.

4.7 Functional check of O_2 flush

Call up service menu "Ventilator test".
Deflate manual breathing bag.
Set MV3 to "man" position.
Press the O_2 flush button.
The manual breathing bag should inflate. O

4.8 Functional check of low-pressure regulator Pvor (DR 1.8 bar)

Call up service menu "Ventilator test".
Set the flow valve to 20 L/min and MV3 to "man".
Record P_{vor} at ambient pressure.
Set MV2 to "open".
P_{vor} = 1800 ±100 mbar above P_{vor} value at ambient pressure. V
Set MV2 to "close"

Set the flow valve to 75 L/min.
Set MV2 to "open".
P_{vor} = 1800 ±300 mbar above P_{vor} value at ambient pressure. V
Set MV2 to "close".
Set flow valve to approx. 20 L/min.

4.9 Functional check of driving gas changeover MV5

Call up service menu "Ventilator test".
Set MV3 to "man", MV5 to "AIR", and MV2 to "open".
P_{vor} = 1800 ±300 mbar above P_{vor} value at ambient pressure. V
Disconnect AIR pipeline supply.
P_{vor} indicates the ambient pressure. V
Set MV5 to "O_2".
P_{vor} = 1800 ±300 mbar above P_{vor} value at ambient pressure. V
Set MV5 to "AIR" and MV2 to "close".
Reconnect AIR pipeline supply.

4.10 Calibrating and testing pressure sensors

Note: In the US version, P_{air} is a differential pressure sensor and therefore not tested in this test step.

Disconnect patient system (breathing system).
Call up service menu "pressure".
Calibrate sensor P_{awm} by pressing "Cal Pres" key. Error 0 indicates no error.
Call up "EDOS test", disconnect pipeline supply.
Set pipeline valves ZV AIR, ZV N_2O, ZV O_2 to "open" and V7 to position "open".
P_{tank} and P_{sys} deviation ±50 mbar. O

P_{tank} and P_{vor} deviation ±100 mbar. O

P_{tank} and P_{air} deviation ± 100 mbar (does not apply to US version). O

P_{awM} = 0 ±2 mbar, P_{awV} = 0 ±2 mbar O
Set V7 to "close", set pipeline valves ZV AIR, ZV N_2O and ZV O_2 to "close".

4.11 Safety valve check

Connect system to pipeline supply.
Mount breathing system, seal off Y-piece.
Call up service menu "VentEDOS".
Using the control knob, select menu item "Servicetest".
Select test 23 "PSI Safety Reduction Valve", start the test and switch immediately to "EDOS Test" menu using the "MAN/SPONT" key.
As soon as you can hear the gas flow at the open psi safety valve, compare the P_{awM} and P_{awV} pressures.
The two pressures must not deviate by more than 4 mbar. O
Using the "MAN/SPONT" key, return to the "SpO_2/VentEDOS" menu.
The displayed PSI pressure should be 75 to 90 mbar.

4.12 Functional check of SpO_2 measurement (optional)

Connect SpO_2 sensor and measure your own oxygen saturation.
The displayed value should be > 90%. O

4.13 Functional check of IRIA

Note: Perform tolerance tests of IRIA only in the status "fully accuracy mode". Read the status in the IRIA service menu under "general state".

4.13.1 Pump test

Call up service menu "IRIA".
Set pump status to "OFF".
The value shown under "pressure" corresponds to the ambient pressure.
Set pump status to "HIGH", seal off sampling hose.
The decrease in pressure shown under "pressure" should be > 240 mbar in relation to ambient pressure. O
"general state" should change form 0 to 40 within 20 seconds.

4.13.2 Water separator

Disconnect sampling hose from water trap.
The pressure difference between water separator fitted and water separator not fitted should be < 70 mbar. O
Connect sampling hose to water trap.

4.13.3 Concentration calibration with calibration gases CO2 and N2O (Minican)

Note: This test step is not applicable if you use calibration gas from Scott Medical with 1% desflurane.

Connect calibration gas canister (8290271 and 8290272) to sampling line of IRIA via calibration adapter (8290301).

Open the calibration gas canister. The CO_2 curve should rise sharply. O

Deviation from calibration gas CO_2 should not exceed 0.2 vol.% (<5.3%). V

Deviation from calibration gas N_2O should not exceed 2.5 vol.% (<40%). V

4.13.4 Anaesthetic gas measurement check

Note: This test step is not applicable if you use calibration gas from Scott Medical with 1% desflurane.

Mount tested vaporizer.
Call up service menu "EDOS test".
Set ZV AIR to "open" and V10 to 2 L/min.
Call up service menu "IRIA".
Set vaporizer, for example, to 2 vol.% (or 6 vol.% for desflurane).
Measure mixed gas at the inspiratory port.

The anaesthetic gas detected should be displayed. The measured value (digital and curve) should correspond approximately to the value set on the vaporizer. O
Set the vaporizer to 0 vol.%.
Call up the service menu "EDOS test".
Set ZV AIR to "close" and V10 to 0 L/min.

4.13.5 Concentration calibration with calibration gases desflurane, CO2, and N2O from Scott Medical

Note: This test step is not applicable if you have calibrated the concentration according to test steps 4.13.3 and 4.13.4.

Connect calibration gas canister (7910345 and 7910346 or similar item which meets the specifications of the calibration gas) to sampling line of IRIA via calibration adapter (8290301).

Open the calibration gas canister. The CO_2 curve should rise sharply. O

Deviation from calibration gas CO_2 should not exceed 0.2 vol.%. O

Deviation from calibration gas N_2O should not exceed 2.5 vol.%. O

Deviation from calibration gas desflurane should not exceed 0.2 vol.%. V

Switch off Julian.

4.14 Power-on self-test

Connect Julian to AC outlet and switch Julian on.
Read software version and enter under test item 1.1.

4.14.1 Check that power-on self-test is completed successfully. O

4.14.2 Leakage rate should be < 85 mL/min. V

4.15 Flow sensor calibration

Make sure Julian is in standby mode.
Start the Service Mode.
Call up service menu "Flow/Temp".
Disconnect expiratory hose from patient system and seal expiratory port.

Start calibration by pressing the ">0<" key.
The value at UR15 should be between 1000 and 1020. O
Exit the Service Mode by pressing the "EXIT" key.
Julian should carry out a warm start and return to standby mode.

4.16 **Gas type test** in "MAN/SPONT"

Set the fresh gas to 50% O_2, the flow rate to 6 L/min, and "N_2O".
The pipeline pressure gauges (digital displays in the US version) should indicate the pipeline pressure. O

4.16.1 Interrupt O_2 supply

The pressure indicated on the O_2 pipeline pressure gauge (O_2 digital display in the US version) should decrease to 0 bar. O

The warning "O_2 SUPPLY ?!!!" should appear. O
If applicable, open the flow control valve of the external O_2 flowmeter tube (optional).
The external O_2 flowmeter tube float should indicate no flow. O
Re-establish O_2 supply.
The warning should disappear.
The external O_2 flowmeter tube float should indicate a flow. O
Close the flow control valve of the external O_2 flowmeter tube.

4.16.2 Interrupt N_2O supply

The pressure indicated on the N_2O pipeline pressure gauge (N_2O digital display in the US version) should decrease to 0 bar. O

The warning "N_2O SUPPLY ?!!!" should appear. O
Re-establish N_2O supply.
The warning should disappear. O

4.16.3 Change mixture to "AIR".
Perform AIR test as for N_2O.
The info "AIR SUPPLY !" should appear.
The warning "AIR SUPPLY !!!" should appear. O

4.17 Breathing system heater

Temperature felt should be noticeably higher than room temperature. O

4.18 Ventilation modes

4.18.1 Manual ventilation

Set Julian to "MAN/SPONT". O
Perform ventilation with manual breathing bag and test lung.

4.18.2 Spontaneous breathing

Switch APL valve to "SPONT". O
Simulate breathing using test thorax.

4.18.3 A-cone (optional)

Set fresh gas to 12 L/min., switch fresh gas to external.
Fresh-gas flow should be noticeable at A-cone outlet. O

4.18.4 PCV

Adjust the following values: P_{max} = 20 mbar; f = 6/min; inspiratory flow = 30 L/min.
Plat. should be 20 ±3 mbar. V

4.18.5 IPPV

Use manual breathing bag as test lung.
Adjust the following values: P_{max} = 60 mbar; V_T = 800 mL; f = 10/min; T_I:T_E = 1:1;
T_{ip}:T_i = 50; PEEP = 10 mbar
After approximately 10 breaths, PEEP should be 10 mbar ±2 mbar. V

For Julian with software version 1.04 or earlier:
VT display = (0.8 L - V_{TC}) ±0.06 L.
For Julian with software version 2.0 or later:
VT display = (0.8 L) ±0.06 L. . V

Note: V_{TC} = (Plat. - PEEP) * 4 mL/mbar.

4.19 Alarm function

Set upper alarm limit of PAW to below peak value.
The text message "PAW HIGH !!!" should appear. O
A visual alarm (LED) should appear and an audible alarm should sound.

4.20 **Water trap level detector** (for systems with optical water trap level detector only)

2/3 fill water separator with water.
"Water trap?!" should appear in info field. O

4.21 Power failure alarm

Disconnect power plug during operation (e.g. IPPV).
The info "POWER FAIL!" and " xx%" should appear. O
Julian should continue to operate from internal battery supply.
Switch Julian off and wait for complete shutdown.
Switch Julian on.
The power failure alarm should sound for more than 30 seconds. O

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5. Supply Julian to customer ready for operation C

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6. Confirmation of test

Name, date, signature

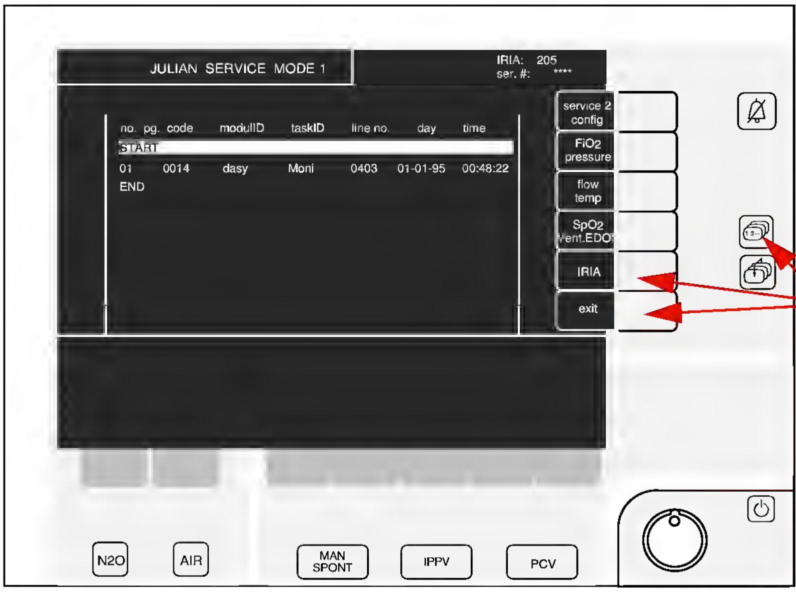
7. Report

8. Appendix

8.1 Accessing the Service Mode

Switch on Julian and supply with pipeline gas. Acknowledge checklist.

The Service Mode can be accessed during the power-on self-test after confirming the check list and after completion of test step 16.



To access the Service Mode, press these keys at the same time.

After pressing "SpO2/VentEDOS" key:

Enter "EDOS test" menu by pressing MAN SPONT.

Enter "Ventilator test" menu by pressing IPPV.

Read out operating hours in "Julian Service Mode 2"

Switch off Julian to exit from Service Mode.

Dräger

DrägerService

Test Certificate

Julian Breathing System

File no.: 5132.010
Edition: 02/2000

Installation site: ______________________

Serial no.: ______________________

Date of delivery/ startup: ______________________

Invoice no. or delivery no.: ______________________

Other: ______________________

Explanation of Symbols

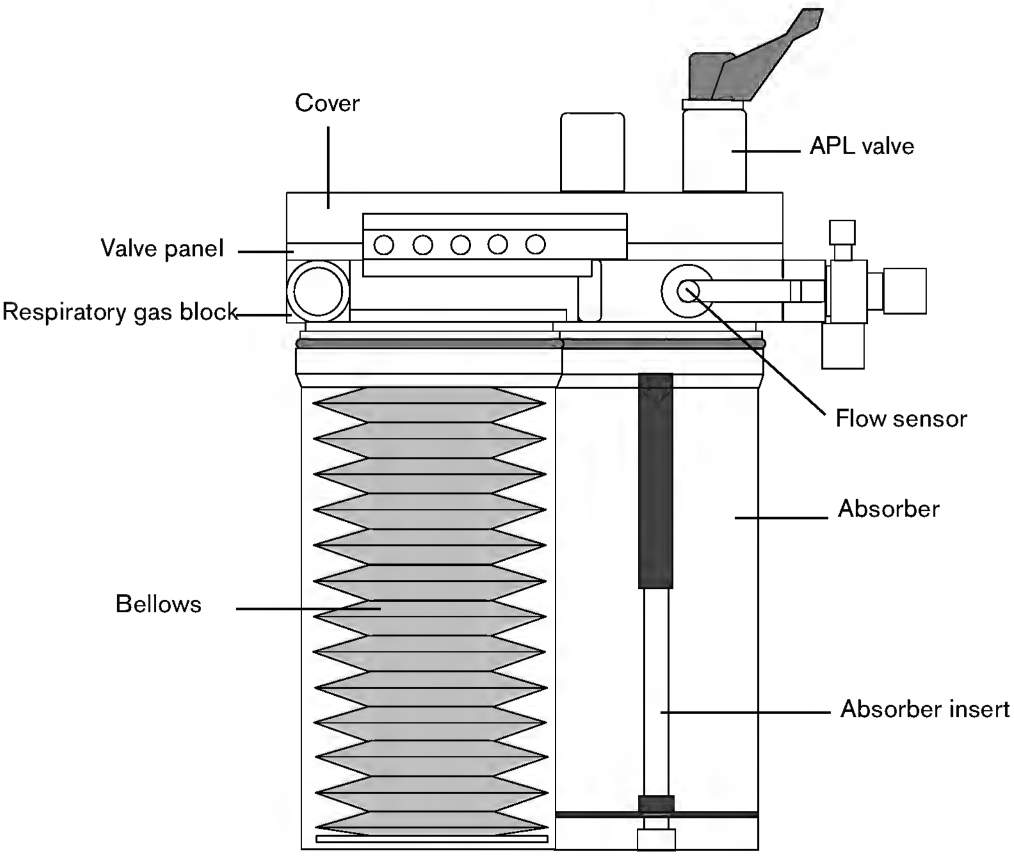
—	OK	C = Check condition
|	Defect/error/fault	O = Check function
◯	Spare parts used	L = Check for leaks
/	Report	V = Enter value
∩	Accessories missing	N/A = Not applicable

Note:

Test Certificate 5132.010 applies to all breathing systems used with Julian and supplements the master Test Certificate or Safety and Function Test 5132.000.

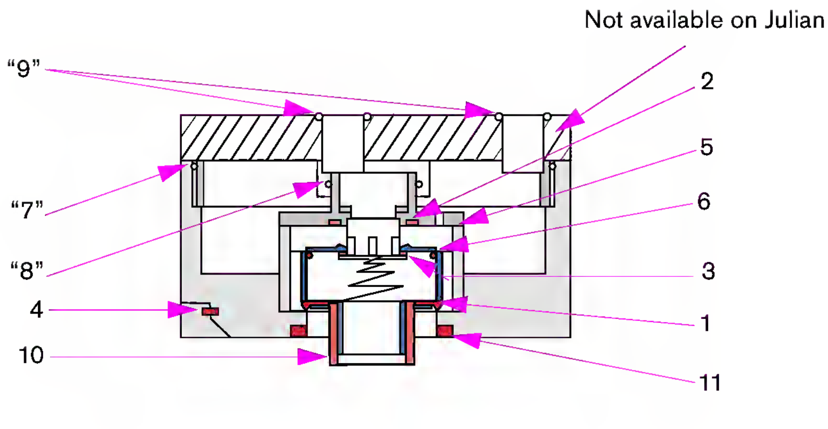
Applies to USA: IPPV = CMV
Applies to France: IPPV = VC
PCV = VPC

Conversion table:
1 bar = 14.504 PSI
1 mbar = 1.01973 cmH_2O



	Serial number of Julian used for testing.	V	
	Serial numbers on breathing system:		
	Cover: (The number is located at the edge of the APL valve disc)	V	
	Valve panel: Number of the expiratory valve crater	V	
	Number of the inspiratory valve crater	V	
	Respiratory gas block: Number of the PEEP valve crater (The first batch of approx. 100 breathing systems does not have this serial number)	V	
1.	Condition of the breathing system	C	
2.	Inspection of accessories, hoses, Y-piece, etc.	C	
3.	Absorber		
3.1	Absorber canister M 33719	C	
3.2	Absorber insert M 33720	C	
3.2.1	Seal on the absorber insert M 33728	C	
3.3	Absorber canister seal on breathing system M 33723	C	
3.4	Absorber insert double seal on breathing system M 33725	C	

3.5 Disposable absorber Drägersorb® CLIC (optional)



3.5.1 Mounting mechanism for Drägersorb® CLIC C

3.5.2 * Replace set of seals (MX 08000) for absorber once a year.

Includes:

1 x seal (10)
1 x seal (11) C

Next replacement:____________________

3.5.3 * Replace set of seals (MX 08001) for absorber twice a year.

Includes:

1 x seal (1)
1 x sealing washer (2)
1 x sealing washer (3)
2 x rubber silencer (4, replace only if necessary)
1 x O-ring (5)
1 x O-ring (6)
1 x O-ring ("7" - not required)
1 x O-ring ("8" - not required)
2 x O-ring ("9" - not required)

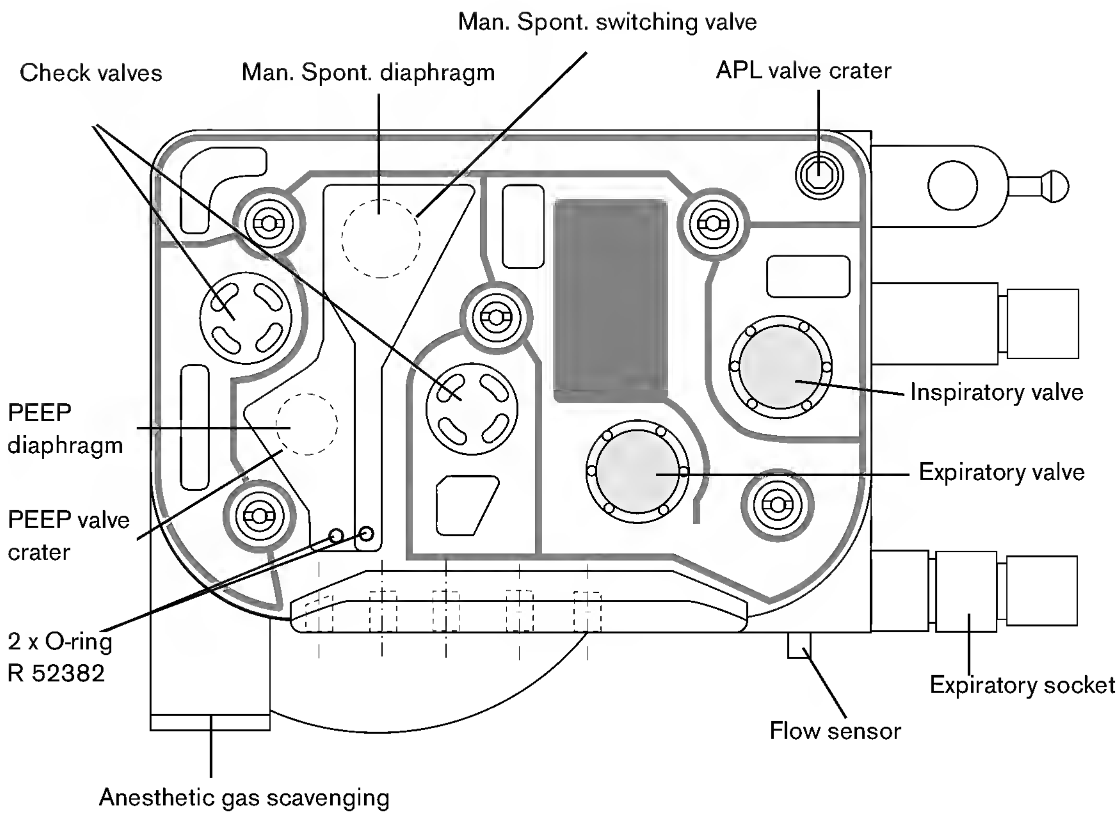
Next replacement:____________________

4. Bellows

4.1 Bellows container M 33718 C

4.2 Bellows container seal on breathing system M 33726 C

4.3 Bellows, complete, M 33841 C



5.	Respiratory gas block, in general	C	☐☐☐☐☐☐☐☐☐☐
5.1	Sealing ring for anesthetic gas scavenging (M 33729)	C	☐☐☐☐☐☐☐☐☐☐
5.2	2 x flow sensor sealing ring (2M 8777) (expiratory socket and respiratory gas block)	C	☐☐☐☐☐☐☐☐☐☐
5.3	PEEP valve crater on respiratory gas block Crater (M 33807) O-ring (M 30405)	C	☐☐☐☐☐☐☐☐☐☐
5.4	Man. Spont. switching valve on Respiratory gas block Respiratory gas block crater (M 33804) O-ring (M 30405) Closing plate (M 33845) Valve crater (M 33799) O-ring (M 33809)	C	☐☐☐☐☐☐☐☐☐☐
6.	Valve plate, in general	C	☐☐☐☐☐☐☐☐☐☐

6.1	Replacement of diaphragm every 2 years			
	Man.Spont. diaphragms	(M 33765)		
	PEEP diaphragm PEEP diaphragm sealing washer(8407979)	(M 33275)		
	2 x O-ring	(R 52382)		
*	Replace every 2 years.		C	□□□□□□□□□□
	Next replacement:__________________			
6.2	Check valves (M 33832)		C	□□□□□□□□□□
6.3	Inspiratory/expiratory valves			
	Note: Pins must not be bent and there must not be any surface damage or scoring in the inside of the valve disc guide.			
	2 x crater	(M 33831)	C	□□□□□□□□□□
	2 x plate	(M 23225)	C	□□□□□□□□□□
6.4	APL valve crater (M 33850)		C	□□□□□□□□□□

7.	Cover, in general	C	□□□□□□□□□□
7.1	Handle	C	□□□□□□□□□□
7.2	APL valve	C	□□□□□□□□□□
7.3	Seal, 5 x M 33826	C	□□□□□□□□□□

8. Functional check

Note:
Functional checking of breathing system is performed in the course of inspection with the entire unit as part of the work involved with the master Test Certificate 5132.000. To avoid redundant checks, checking according to test item 9. in this Test Certificate is not applicable in this case. Perform test item 9 only if further breathing systems are to be checked separately (independent of the Test Certificate or Safety Function Test of the entire unit).
When performing the Safety and Function Test 5132.000 to Julian, the breathing system function test in this Test Certificate is also carried out, except for test item 9.2.1. In this case, only test item 9.2.1 needs to be carried out.

The test items under test item 8. are entered after carrying out the procedures according to the Julian Test Certificate/Safety and Funtion Test.

If other breathing systems are to be checked, that is separately from the entire system, proceed to function test under test item 9. of this Test Certificate. The test item 8. is then not applicable.

Power-on self-test according to master Julian Test Certificate/Safety and Function Test successfully completed.	O										
Leakage ≤ 85 mL/min.	V										
Ventilation mode function test according to master Julian Test Certificate/Safety and Function Test successfully completed.	C										

8.1 For breathing systems with disposable absorber Drägersorb® CLIC (optional)

Perform standby leak test with absorber container folded down (bypass function).

Leakage ≤ 85 mL/min.	V										

---

9. Function test for additional breathing systems

9.1 Power-on test

Fully assemble Julian.
Mount the breathing system.
Switch on Julian.
Acknowledge the check list and allow the power-on self-test to complete.

Leakage ≤ 85 mL/min.	V	
Power-on self-test successfully completed.	O	

9.2 Ventilation mode function test

Julian is in standby.

Fresh-gas setting:
Press the Air button and acknowledge.
Set O_2 concentration to 25%.

9.2.1 Manual ventilation, APL valve

Press the "Man.Spont." button and acknowledge with the control knob.

Julian switches to operating mode Man./Spont.	O	

Remove the manual breathing bag and connect test pressure gauge 7901515.

Set the fresh-gas flow 10 L/min.

Set the following values with the APL valve and read off on pressure gauge:

Setting:	Measured value		
10 mbar	7 - 13 mbar	O	
30 mbar	25 - 35 mbar	O	
70 mbar	60 - 80 mbar	O	

Set the APL valve to 30 mbar.
Set the flow 3 L/min.
Connect the manual breathing bag.

Connect the test thorax. Carry out manual ventilation.	O	

9.2.2 Spontaneous breathing

Set APL valve to "Spont" position. Spontaneous breathing can be carried out with the test thorax. Set APL valve to "Man" position.	O	

9.2.3 IPPV ventilation

Press the "IPPV" button and acknowledge with the control knob.

Julian switches to "IPPV" mode.	O	

Ventilation parameters setting:

P_{max}	: 60 mbar
V_T	: 800 mL
Freq.	: 10/min
T_I:T_E	: 1:1
T_{ip}:T_i	: 50
PEEP	: 10 mbar

Press the O2 flush button in order to fill the test thorax.

Press the "Adjust limits" button.

Use the button to select the data screen.

Check the following PEEP value after approx. 10 breaths:
PEEP = 10 ± 2 mbar V

The bellows in the bellows container rises by 8 ±1 graduation marks. (If an error occurs, refer to repair information "Bellows do not rise"). O

Applies to Julian with software version 1.04 or earlier:
$V_T = (0.8\ L - V_{TC}) \pm 0.06\ L$ V

Applies to Julian with software version 2.0 or later:
$V_T = (0.8\ L) \pm 0.06\ L$

Note concerning Julian with software version 1.04 or earlier:
V_{TC} = Loss due to breathing system compliance.
V_{TC} = (Plat. - PEEP) times 4 mL/mbar.

Switch Julian to standby.

9.3 For breathing systems with disposable absorber Drägersorb® CLIC (optional)

Perform standby leak test with absorber container folded down (bypass function).

Leakage $\leq$ 85 mL/min. V

Switch off Julian.

---

10. Supply unit to customer ready for operation.

11. Confirmation of test

Name:

Date:

Signature:

---

* These steps are regarded as repair work and are therefore not included in the inspection service price.

12. Report:

13 Spare Parts Required for Julian Breathing System (as applicable)

Every 12 months

Set of seals for disposable absorber Drägersorb® CLIC (optional)	MX 08000

Every 2 years

PEEP diaphragm	M 33275
PEEP diaphragm sealing washer	84 07979
Man./Spont. diaphragm assembly	M 33 765
2 x O-ring (diaphragm assembly cover)	R 52382
Set of seals for disposable absorber Drägersorb® CLIC (optional)	MX 08001

As necessary

Absorber canister	M 33 719
Absorber insert	M 33 720
Absorber insert container seal	M 33 728
Absorber insert breathing system seal	M 33 725
Absorber insert breathing system seal	M 33 723
Bellows container	M 33 718
Bellows container-breathing system seal	M 33 726
Bellows, complete	M 33 841
Anesthetic gas scavenging seal	M 33 729
Flow sensor seal	2M 8 777
APL valve crater	M 33 807
APL valve crater seal	M 30 405
Man./Spont. switching crater, respiratory gas block	M 33 804
Man./Spont. O-ring crater	M 30 405
Closing plate	M 33 845
Valve crater	M 33 799
Valve crater O-ring	M 33 809
Non-return valve	M 33 832
Insp./exp. valve crater	M 33 831
Insp./exp. valve plate	M 23 225
APL valve crater	M 33 850
5 x cover fastener	M 33 826

14 Test Equipment for Julian Breathing System

Pliers, locking mechanism A21 (for valve crater replacement)	7910 359

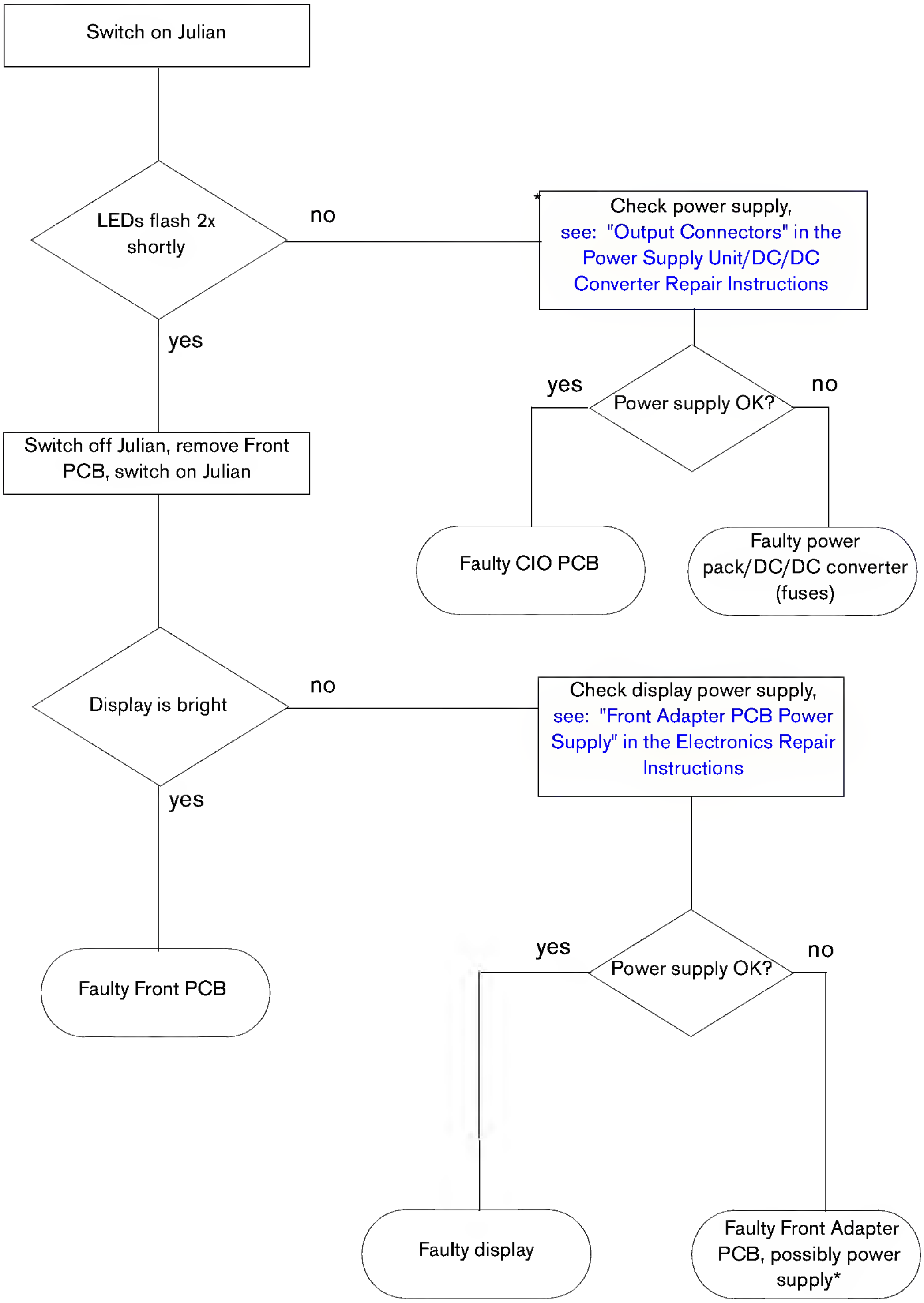
Repair Instructions

1 Repair Information/Error Events

new	Repair Information	Described in:
	General	
	General Information	Chapter 45 "General Service Information" in the Electronics Error List.
	Unusual whistling noise from Julian	Chapter 4 "Whistling Noise" in the Pneumatics Repair Instructions.
	Pneumatics/Breathing System	
X	Offset calibration of PEEP valve in case of fault in test step 18	Chapter 14.2 "Offset Calibration of PEEP Valve in Case of Fault in Test Step 18" in the Pneumatics Repair Instructions.
X	Actuator PCB, **installing new Pressure PCB (8603361)**	Chapter 5.1.1 "Installation instructions for new Pressure PCB 8603361" in the Pneumatics Repair Instructions.
	Mounting new non-return valves on the gas inlet block.	Chapter 16.2 "Mounting New Non-return Valves on the Gas Inlet Block" in the Pneumatics Repair Instructions.
	Central-supply inlet-valve (M32944) assembly fault	Chapter 11.2 "Incorrect Assembly of Clippard 2/2-Way Valves (M32944)" in the Pneumatics Repair Instructions.
	CS system inlet valves flow calibration.	Chapter 11.3 "CS System Inlet Valves Flow Calibration" in the Pneumatics Repair Instructions.
	Blockage or partial blockage of hose system.	Chapter 11.4 "Blockage in EDOS Hose System" in the Pneumatics Repair Instructions.
	Leak in EDOS block.	Chapter 11.5 "EDOS Leak Test" in the Pneumatics Repair Instructions.
	Gas concentration in breathing system is too low	Chapter 22.1 "Breathing System Faults" in the Pneumatics Repair Instructions.
	Bellows does not ascend.	
	Error in self-test step 31 "Faulty bellows light barrier" (provided that harware of bellows light barrier is fitted).	

new	Repair Information	Described in:
	Error in self-test step 33. Major leaks detected during leak test. No pressure buildup possible during operation.	Chapter 20.1 "Pneumatic Interface Repair Info" in the Pneumatics Repair Instructions.
	Power Supply Unit/DC Converter	
X	Correct sequence of dismounting/mounting of the power supply unit or the DC converter.	Chapter 32.4 "Replacing Power Supply Unit" in the Power Supply Unit Repair Instructions.
	Sporadic occurrence of safety mode	Chapter 32.11.4 "Sporadic Occurrence of Safety Mode" in the Power Supply Unit Repair Instructions.
	Message “Mains failure battery defective”	Chapter "Software 1.01: Self-test message "backup battery defective"" in the Electronics Error List.
	Incorrect “mains failure!” info	Chapter 32.11.3 "Incorrect "mains failure!" Message" in the Power Supply Unit Repair Instructions.
	Electronics	
	Display blanked	Chapter 1.1 "Error – Display Blanked –" in this document.
	Replacement of the following boards: CIO PCB, Ventdos Controller PCB, Repair/Exchange Ventdos Controller PCB.	Chapter 27.7 "CIOP CB Repair Information" in the Electronics Repair Instructions.
	Error log with error code 12005	Chapter 29.5.1 "Error Log with Error Code 12005" in the Electronics Repair Instructions.
	"Afterglowing" of display	Chapter 29.5.2 ""Afterglowing" of Julian Display" in the Electronics Repair Instructions.
	IRIA	
	IRIA module fails to supply pump flow	Chapter 35.10.1 "IRIA Module, No Pump Flow" in the Iria Module Repair Instructions.
	The measured-value field for desflurane is blanked as soon as the desflurane concentration exceeds 9.9 vol.%.	Chapter 35.10.2 "Display Error with Desflurane Measurement up to Software 1.04" in the Iria Module Repair Instructions.

1.1 Error – Display Blanked –



2 Pneumatics

Contents

3 Dismounting/Mounting a Wall-Mounted or Ceiling-Mounted Julian

If you need to repair a ceiling-mounted Julian or work on the EDOS block of a wall-mounted Julian, you must lift the respective machine off its mount first.

Risk of personal injury and/or damage to equipment. Make sure not to drop Julian when lifting it down. The machine is heavy (about 75 kg). Julian should only be lifted off its mount by two persons.

3.1 Dismounting a Wall-Mounted Julian

Loosen screws **A** on upper bracket (do not remove). If you remove screws, sliding block (threaded metal piece) will drop into mount. If this happens, you need to remove entire mount from the wall.

- Loosen two screws A on upper bracket (you do not need to loosen screws on lower bracket). When remounting machine, tighten screws A with a torque of 11 Nm ±10%. To do so, you will need the following tools:

  Bit, 5 mm, drive, 8 mm, item no. 7910723
  Bit holder, 8 mm, item no. 7901799
  Torque wrench, item no. 7900909

- Remove upper bracket **B** from its guide.

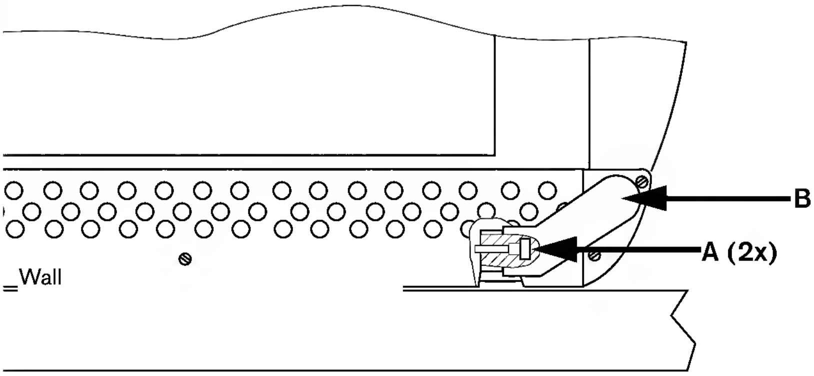


Fig. 1: Dismounting a wall-mounted Julian (top view)

- Lift Julian off lower bracket (this should be done by two persons).

If you need to work on the EDOS block, dismount side member first (see "Dismounting Side Member").

3.1.1 Dismounting Side Member

Screws **B** on the side member are "furniture screws". To loosen, turn them approx. 110° counter-clockwise.

- Loosen 4 screws **B** on side member.
- Remove screw **C** from side member.

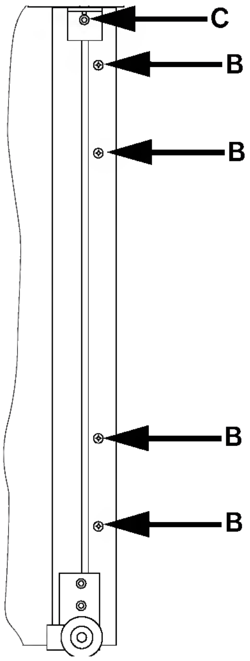


Fig. 2: Dismounting side member (view of right side member, inside)

- Remove side member.

3.2 Mounting a Wall-Mounted Julian

- Mount wall-mounted Julian using reverse method of that used for dismounting.

Risk of personal injury and/or damage to equipment. Make sure mount is secured properly to avoid risk of Julian falling off ceiling mount. Align mount and tighten screws of mount with a torque of 11 Nm ±10%.

To do so, you will need the following tools:
Bit, 5 mm, drive, 8 mm, item no. 7910723
Bit holder, 8 mm, item no. 7901799
Torque wrench, item no. 7900909

- Check Julian according to relevant Test Certificate, depending on service work performed.

3.3 Dismounting a Ceiling-Mounted Julian

- Lift Julian off its mount (this should be done by two persons).
- US-variant: Remove reserve gas cylinders and cylinder holder. When re-installing the reserve gas cylinders and cylinder holder, follow the "Installation Instructions Julian USA Ceiling" under "Conversion Instructions".
- Remove screws **A**.
- Remove screws **B** (when remounting machine, tighten these screws with a torque of 11 Nm ±10%).
  To do so, you will need the following tools:
  Bit, 5 mm, drive, 8 mm, item no. 7910723
  Bit holder, 8 mm, item no. 7901799
  Torque wrench, item no. 7900909
  Open-end wrench set, item no. 7910556 (for USA-variant only - fixing screw B top right, 10 mm hex bolt).

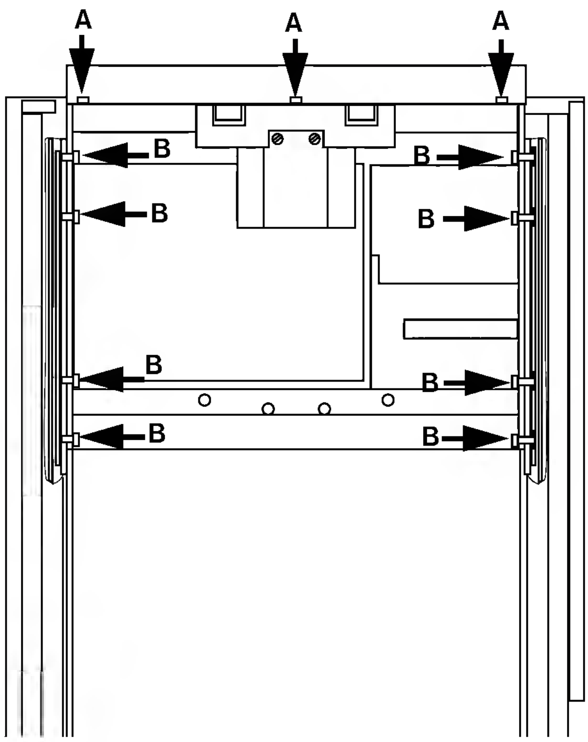


Fig. 3: Dismounting ceiling mount

- Remove mounting plate including cross-bars.

You can now remove rear panel of Julian. If you need to work on EDOS block, dismount side member first (see "Dismounting Side Member").

3.3.1 Dismounting Side Member

Screws **C** on side member are "furniture screws". To loosen, turn them approx. 110 ° counter-clockwise.

- Loosen 4 screws **C** on side member.
- Remove screw **D** from side member.

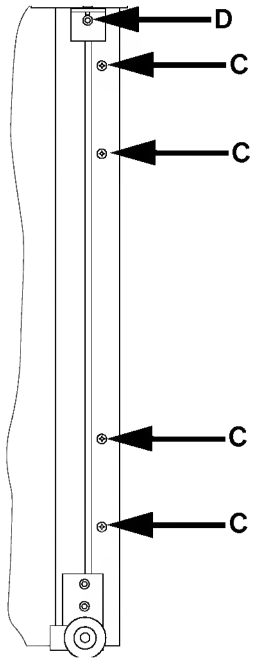


Fig. 4: Dismounting side member

- Remove side member.

3.4 Mounting a Ceiling-Mounted Julian

- Mount ceiling-mounted Julian using reverse method of that used for dismounting. US-variant: Follow the "Installation Instructions Julian USA Ceiling" under "Conversion Instructions".

Risk of personal injury and/or damage to equipment.
Make sure ceiling cross-piece is secured properly to avoid risk of Julian falling off ceiling pendant head. Tighten screws of cross-piece to a torque of 11 Nm ±10%.

To do so, you will need the following tools:
Bit, 5 mm, drive, 8 mm, item no. 7910723
Bit holder, 8 mm, item no. 7901799
Torque wrench, item no. 7900909
Open-end wrench set, item no. 7910556 (for USA-variant only - fixing screw B top right, 10 mm hex bolt).

- Check Julian according to respective Test Certificate, depending on service work performed.

4 Whistling Noise

Whistling noise may have different causes. The following repair information will help you find and remove the causes.

4.1 Allocating the Whistling Noise

First set the following operating mode:

- IPPV; central supply system (CS system) closed, O_2+AIR fresh gas 50% each (switch to "O_2+N_2O" to check the N_2O valve).

Use the following table for an initial allocation of the fault source.

Table 1: Initial allocation of whistling noise

Whistling noise	see chapter
Audible during inspiratory phase only.	4.2.6
Audible during expiratory phase only.	4.2.5
Always audible.	4.2.4 / 4.2.7
Audible during inspiratory phase plus additional tone with respiratory-phase independent frequency.	4.2.1
Only tone with respiratory-phase independent frequency audible.	4.2.2 / 4.2.3
Power failure alarm after switch-off using the power switch	4.2.8

Note:

If it is difficult to detect a whistling noise with respiratory-phase independent frequency, change the fresh-gas flow (e.g. +2 L/min).

4.2 Determining Causes

4.2.1 AIR (CS system) Non-Return Valve/Gas Inlet Block

Set the following operating mode:

- IPPV; fresh gas: O_2 + AIR; O_2 to 25%; CS system connected.

Can you hear a whistling noise during the inspiratory phase (driving gas through MV5) as well as with respiratory-phase independent frequency (flow through ZV1 into mixing container)? If yes:

- Set O_2 to 100%.

Can you hear the whistling noise during the inspiratory phase only? If yes:

- Replace the non-return valve on the AIR NIST connection (see repair information in chapter 16.2 "Mounting New Non-return Valves on the Gas Inlet Block").

4.2.2 O2 (CS system) Non-Return/Valve Gas Inlet Block

Set the following operating mode:

- IPPV; Fresh gas: O_2 + AIR; O_2 to 25%; CS supply connected.

Can you hear a short whistling noise with respiratory-phase independent frequency (flow through ZV2 into mixing container)? If yes:

- Set O_2 to 100%.

Is the whistling noise considerably longer? If yes:

- Replace the non-return valve. (see repair information in chapter 16.2 "Mounting New Non-return Valves on the Gas Inlet Block").

4.2.3 N2O (CS system) Non-Return/Valve Gas Inlet Block

Set the following operating mode:

- IPPV; fresh gas: O_2 + N_2O; O_2 to 25%; CS system connected.

Can you hear a whistling noise with respiratory-phase independent frequency only (flow through ZV1 into the mixing unit)? If yes:

- Set O_2 to 100%.

Can you still hear the whistling noise? If not:

- Replace the non-return valve on the N_2O NIST connection (pipeline system) (see repair information in chapter 16.2 "Mounting New Non-return Valves on the Gas Inlet Block").

4.2.4 MV5/Gas Inlet Block

Set the following operating mode:

- IPPV; fresh gas: O_2 + AIR; CS system connected.

Can you hear a continuous, high-frequency whistling tone? If yes:

- Disconnect the AIR CS system (driving gas switches to O_2).

If the whistling noise has stopped then valve MV5 is the cause. A soft whistling noise will always be audible as the valve is triggered in switching mode. If the whistling noise is very loud (audible also during operation) it can only be removed by replacing the valve.

4.2.5 V1 or RV1/Breathing System

Set the following operating mode:

- IPPV; MV1 (PEEP valve) to 0 mbar; CS system connected.

Can you hear the whistling noise during the expiratory phase only? If yes:

- Increase the PEEP.

Has the whistling noise stopped or decreased considerably? If yes:

- Replace V1 or RV1. A more accurate analysis is not possible for the time being.

4.2.6 PEEP Valve/Ventilator

Set the following operating mode:

- IPPV; CS system connected.

Can you hear the whistling noise during the inspiratory phase only? If yes:

- Connect a length of silicone tube (approx. 3 cm) to the outlet of the PEEP valve (this increases the flow resistance). Otherwise replace the PEEP valve.

4.2.7 Electrical Whistling During Operation

This may be due to the VentDos Controller PCB or CIO PCB.

Can you hear the whistling noise in any mode? If yes:

- Seal the buzzer of the VentDos Controller PCB or of the CIO PCB with one finger.

Does this dampen the tone? If yes:

- Replace the respective board. The cause is a faulty logic gate.

4.2.8 Power Failure Alarm After Switching Off Julian Using the Power Switch

This may be due to the VentDos Controller PCB .

- Check whether the buzzer of the VentDos Controller PCB causes the power failure alarm.

There is a high probability that this fault is caused by a defective Cold-Cap capacitor on the Vent/Dos Controller PCB. Order no. of Gold-Cap capacitor: 1837125.

5 Actuator PCB

Carefully read and follow the message below when replacing the Actuator PCB.

Electrostatic discharge can damage electrostatic sensitive devices. Use a static-dissipative mat and a wrist strap when handling electrostatic sensitive devices.

5.1 Repair Information

5.1.1 Installation instructions for new Pressure PCB 8603361

If the pressure sensor Pfgf or Psys is faulty, the old Pressure Sensor PCB (8201761) must be replaced with the new Pressure PCB 8603361.

Installation procedure:

- Switch off Julian.
- Remove Julian's rear panels.
- Pull out the pneumatic plug-in unit.
- Remove the EDOS block (see DORIS/Julian/Documentation for technicians/Repair Instructions/Pneumatics/EDOS/Removing EDOS).
- Remove the Pressure Sensor PCB (8201761) from the face of the EDOS block.

Caution:

Be careful when pulling out the sensors. Do not lose the O-rings, you will need them for later installation.

- Mount the connector of the enclosed cable harness onto the Actuator PCB (see the following Figure for work steps). To do so, plug the 5-pin, white connector into X18 (A) (left-aligned). Remove jumper X25 (B) and mount the 3-pin, black connector including the connector protection. The two cables of the same color point downwards (jumper simulation).

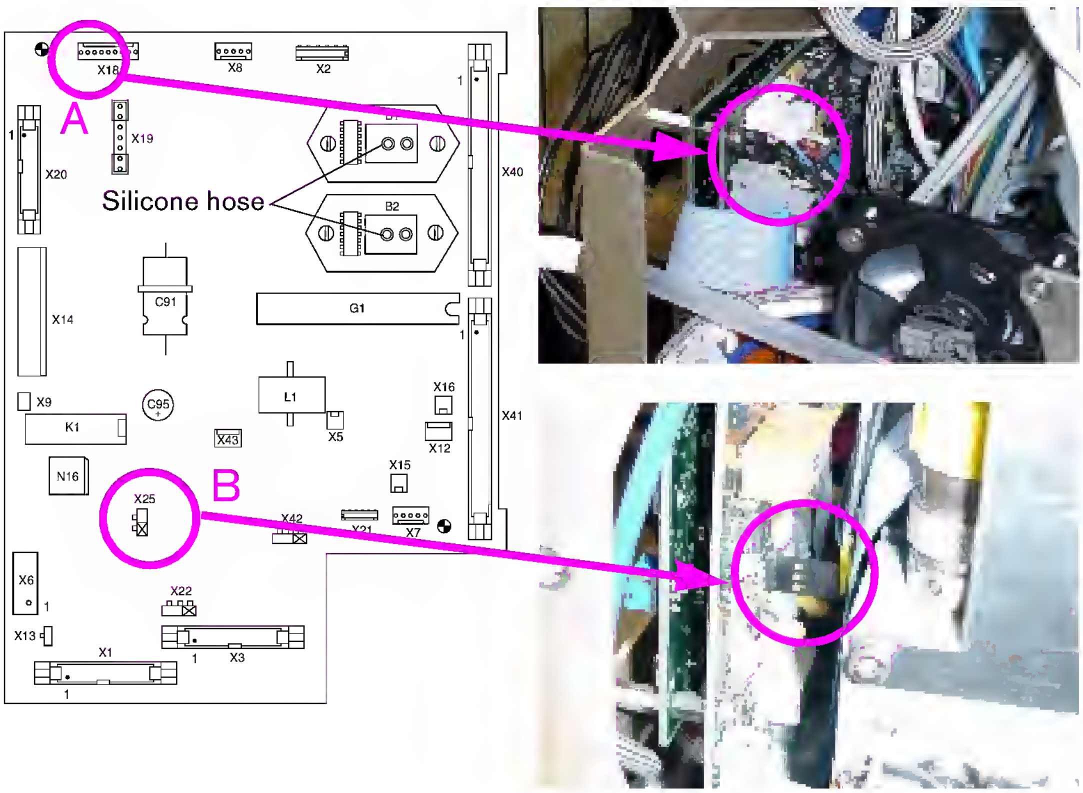


Fig. 5: Location of the connectors

- Mount the new Pressure PCB 8603361 onto the EDOS block (Caution: Do not forget to mount the O-rings). To be able to install the Pressure PCB, you need to remove the piggyback board first, then reinstall it.

Caution:

Upper and lower boards of the Pressure PCB are matched. Therefore, plug in only the corresponding piggyback board.

- Reinstall the EDOS block and connect both connectors to the Pressure PCB (see the following Figure).

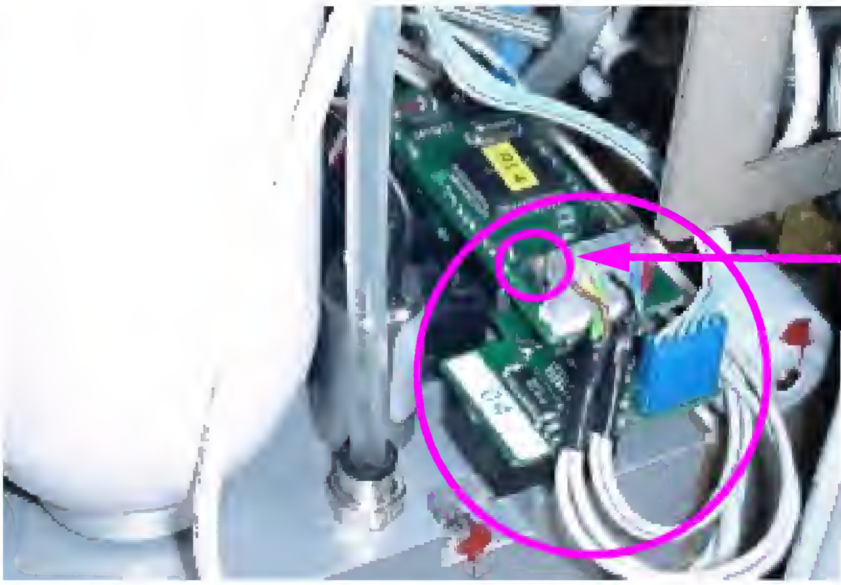


Fig. 6: Installing the connectors of the Pressure PCB

Checking:

- Switch on the Julian. The red LED comes on. The green LED comes on briefly after about 30 seconds. Both LEDs go off afterwards (calibration successfully completed).
- After confirming the check list, immediately start the service mode. Go to the VentE DOS / EDOS test page and set V10 to 1 L/min.
- Press the reset button (see the Figure above) on the new Pressure PCB.
- The test has been successfully completed if the red LED is still on after about 45 seconds. The system checks whether the connector is plugged properly into X25. The Pressure PCB receives flow information from V10.
- Reassemble the Julian.
- Carry out safety test according to Test Certificate (chapter 22).
- Wait until the self-test is complete.
- Check the fresh-gas flow according to Test Certificate (chapter 11.1).
- Check the CO_2 display of the IRIA:
  While the pump is on, breathe into the anesthetic gas sampling tube. The CO_2 value should be displayed.
- Place the fully functional Julian at the user's/owner's disposal.

5.2 Actuator PCB Component Layout

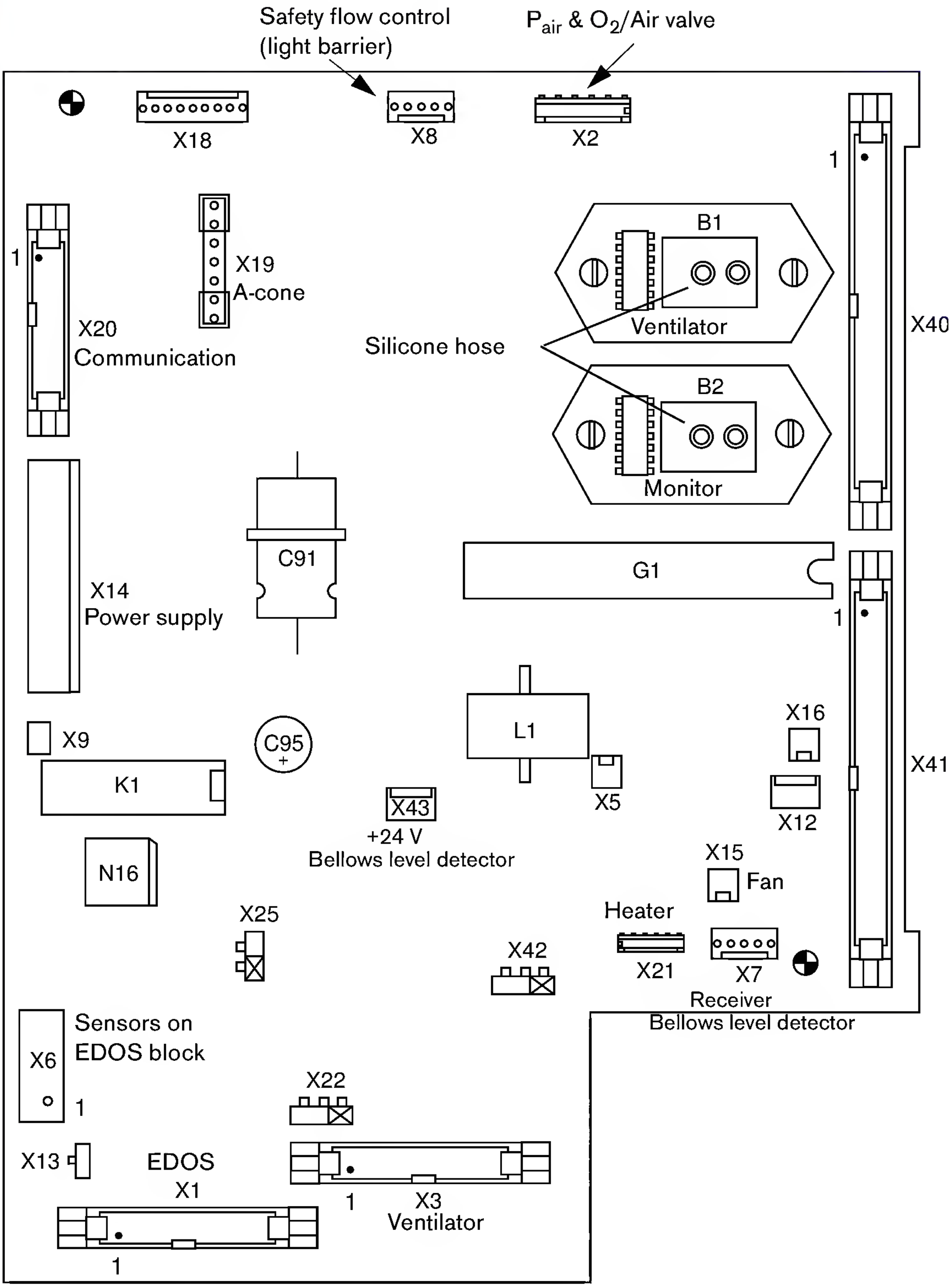


Fig. 7: Actuator PCB component layout

5.3 Voltage Supply to Actuator PCB

X14 (Actuator PCB) corresponds to X111 (Motherboard)	
Pin	Assignment
1	+24 V ±1 V
2	GND 24 V
3	+5.15 V ±0.15 V
4	DGND
5	5 V SENSE +
6	5 V SENSE –
7	Powerfail
8	+15 V ±0.5 V
9	GND analog
10	–15 V ±0.5 V

5.4 Connector Pin Assignment of Actuator PCB

X8 (US variant ->light barrier from safety flow control)			
State	**Pin**		
Receiver	3	4	5
closed	0 V	GND	5 V
open	5 V	GND	5 V
	Pin		
Emitter	1	2	
	approx. 1.2 V	GND	

X20 (Actuator PCB) corresponds to X112 (Motherboard)	
Pin	Assignment
1	CANH
2	CANL
3/4	GNDCAN
5,6,7,8	not assigned

X20 (Actuator PCB) corresponds to X112 (Motherboard) (cont'd)	
Pin	Assignment
9	VERRIEGEL +
10	VERRIEGEL –
11	STATUS +
12	STATUS –
13,14	GND pressure
15	+5 V analog pressure
16	Paw pressure signal
17,18	not assigned
19	I/E
20	DGND

X40 (to Ventdos Controller PCB)			
Pin	Assignment	Pin	Assignment
1	#CS-105-MA	2	#Height
3	Sys-Plug	4	U-Batt (3 V)
5	#Reset-SV	6	Mixer Freq
7	#Vent-Enable	8	#Dose-Enable
9	Flow-PDM	10	+24 V-Vent
11	+24 V-Vent	12	+24 V-Dose
13	+24 V-Dose	14	#Low-Line
15	Stepper-Pos2	16	Stepper-Pos1
17	#Stepper-Boost	18	Stepper-Dir
19	Stepper-Freq	20	Safety-Bi-S2-MA
21	AK-Near-MA	22	Safety-Bi-S1-MA
23	AK-Near-SV	24	Fan-ON
25	Safety-Bi	26	#Fan-State
27	A-cone	28	–
29	O_2/AIR-Stat-MA	30	O_2/AIR-Stat-SV
31	O_2/AIR-PDM	32	PEEP-PDM
33	Vent-NN-GND	34	Vent-Safety-GND
35	Vent-MV3-GND	36	Vent-MV2-GND

X40 (to Ventdos Controller PCB)			
Pin	Assignment	Pin	Assignment
37	Vent-Flush-GND	38	Vent-N2O-GND
39	Vent-AIR-GND	40	Vent-O2-GND
41	–	42	CAN-HI
43	CAN-LO	44	GND-ISO (CAN)
45	GND-ISO (CAN)	46	CAN-HI
47	RXD (TTL)	48	TXD (TTL)
49	NT-Verr-SIg	50	NT-Verr-GND
51	DGND-Sense	52	5 V-Sense
53	PGND (24 V)	54	PGND (24 V)
55	DGND (5 V)	56	DGND (5 V)
57	+24 V	58	+24 V
59	+5 V	60	+5 V

X41 (to Ventdos Controller PCB)			
Pin	Assignment	Pin	Assignment
1	+15 V	2	+15 V
3	AGND (15 V)	4	AGND (15 V)
5	–15 V	6	–15 V
7	P1.3-MA	8	7.2-MA
9	3 V-Batt	10	GND-Batt
11	P7.3-MA	12	PAW-SV
13	PAV-SV	14	Tank-Press-MA
15	Sys-Press-MA	16	P8.3-MA
17	Flow-Ist-MA	18	ZV-AIR-15 V
19	ZV-AIR-GND	20	ZV-NN-MA
21	ZV-AIR-MA	22	ZV-NN-15 V
23	ZV-NN-GND	24	P8.0-MA
25	#AK-Enable	26	#Saf-Bi-Enable
27	Pipe-Heat-C	28	Pipe-Heat-E
29	P5.6-MA	30	Safety-Bi-S1-SV
31	Safety-Bi-S2-SV	32	P5.7-MA

X41 (to Ventdos Controller PCB)			
Pin	Assignment	Pin	Assignment
33	P1.4-SV	34	P3.5-SV
35	P8.0-SV	36	P5.5-SV
37	I/E-C	38	I/E-E
39	P5.6-SV	40	P5.7-SV
41	Static NT-C	42	Stat-NT-E
43	#CS-106-SV	44	#CS-105-SV
45	PAV-15 V	46	#Powerfail
47	PAV-GND	48	PAV-MA
49	PAW-15 V	50	PEEP-SV
51	PAW-GND	52	PAW-MA
53	Sys-Press-SV	54	Tank-Press-SV
55	P5.4-SV	56	–
57	#Reset-MA	58	Heat-C
59	#CS-106-MA	60	Heat-E

5.5 Position of LEDs on Actuator PCB

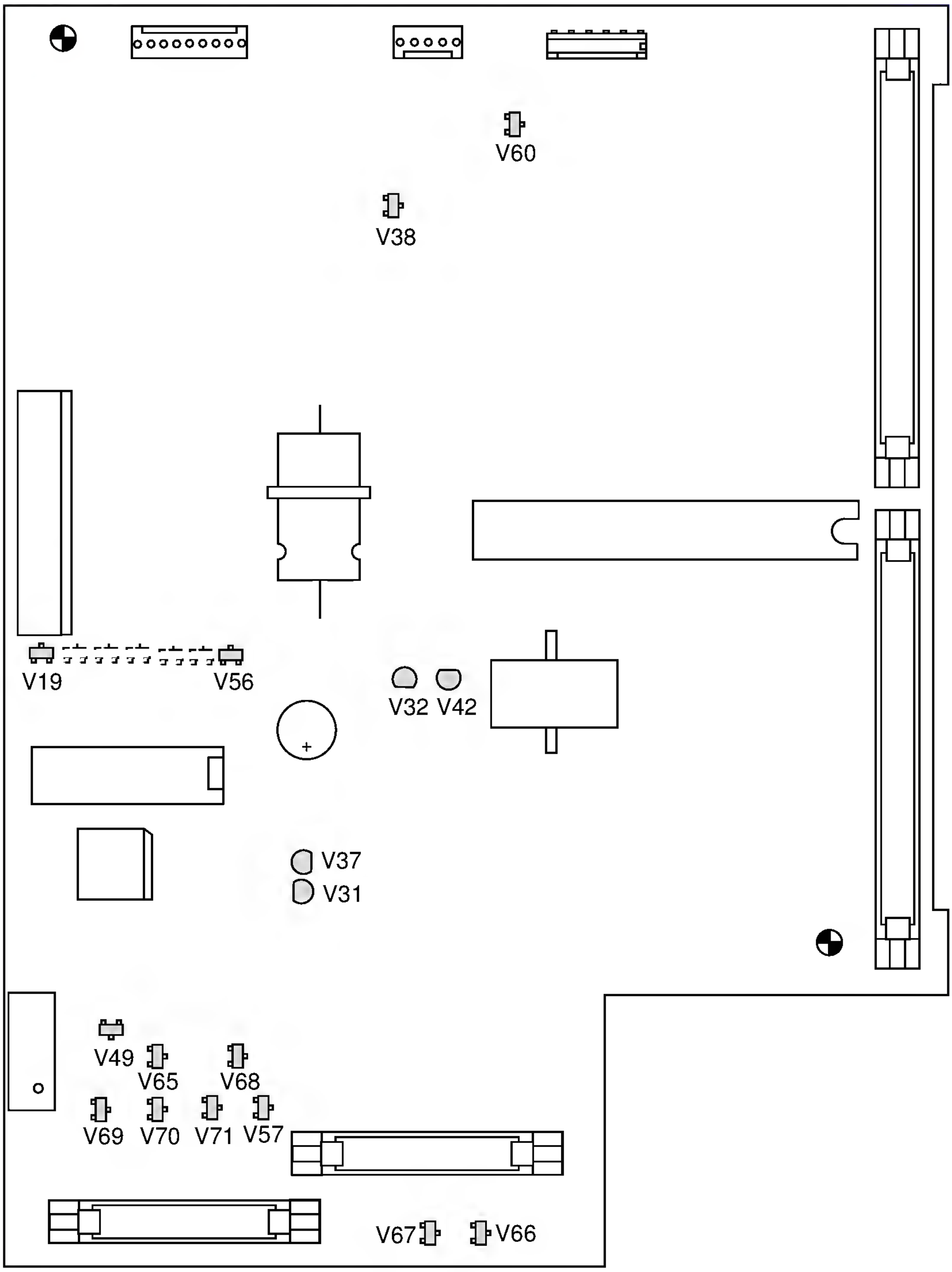


Fig. 8: LEDs on Actuator PCB

5.6 Status of LEDs on Actuator PCB

Valve	Open	Closed	AIR	O_2
	LED display			
V27	V65 off	V65 on		
MV2	V67 on	V67 off		
V7	V68 on	V68 off		
ZV1 AIR	V70 on	V70 off		
ZV2 N_2O	V69 on	V69 off		
ZV3 O_2	V71 on	V71 off		
V28	Red LED V31 on	Green LED V37 on		
MV5			V56 on	V56 off
	Int.	Ext.		
MV6	Green LED V32 on	Red LED V42 on		
	LN	OFF		
Heating	V60 on	V60 off		

5.7 Voltage Supply to Ventilator Valves

	LED on	Voltage
Ventilator	V19	approx. 23 V
PEEP valve	V38	approx. 15 V
Proportional valve	V49	approx. 15 V

Notice: The more the proportional valve opens the brighter the LED V57 shines.

For measuring points, see "Component Layout of Ventdos Controller PCB"			
Valve	Measured at measuring point 1 of V24	Open	Closed
MV2	Measuring point 2 of V4	approx. 23 V	0 V
MV3	Measuring point 2 of V5	approx. 23 V	0 V

5.8 Replacing Actuator PCB

- Switch off Julian.
- Remove rear panels of Julian.
- Pull out pneumatic plug-in unit.
- Remove EDOS block (see "Removing EDOS").
- Remove cable connections **A**.
- Disconnect hoses **B**.

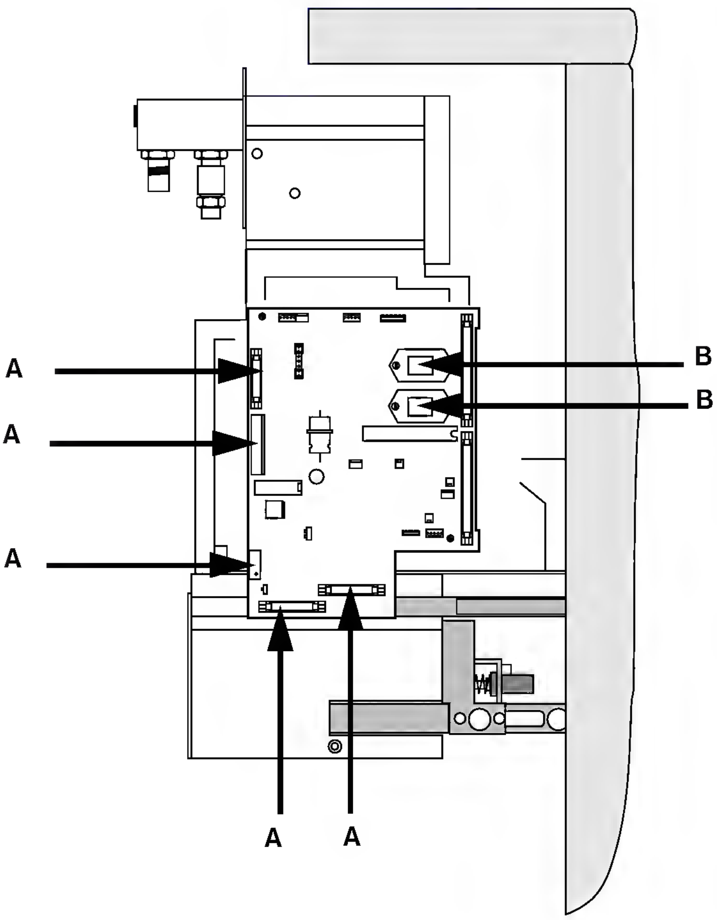


Fig. 9: Replacing Actuator PCB (side view)

- Remove screws **C**.

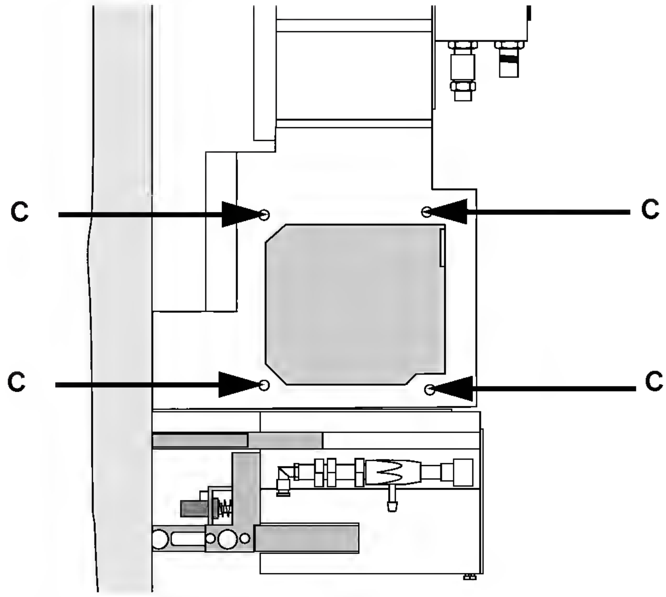


Fig. 10: Removing Actuator PCB (side view)

- Remove Ventdos Controller PCB and Actuator PCB.
- Remove screws which secure Ventdos Controller to Actuator PCB.

Risk of damage to the electronics due to reversed polarity. During installation, make sure the polarity and the plug-in connections are correct.

Risk of malfunction due to kinked or squeezed hoses. Make sure not to kink or squeeze any hoses when reassembling the unit.

- Install new Actuator PCB using reverse method of that used for removing old Actuator PCB.
- Check Julian according to relevant Test Certificate.

6 Mixer Valve Adapter PCB

6.1 Component Layout of Mixer Valve Adapter PCB

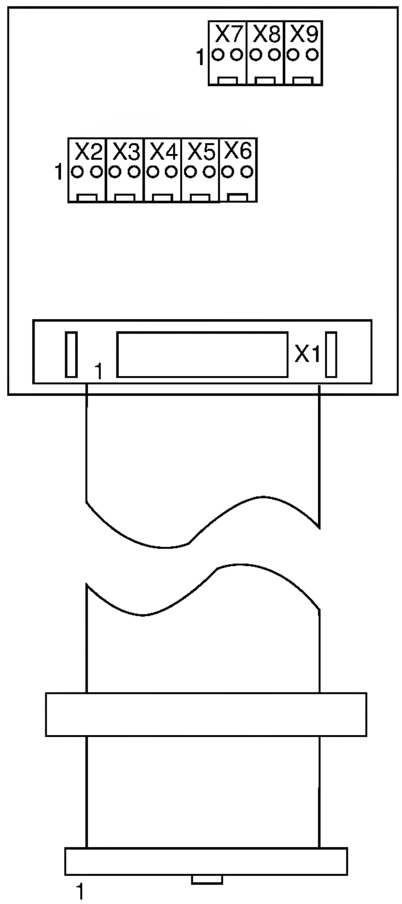


Fig. 11: Component layout of Mixer Valve Adapter PCB

6.2 Connector Pin Assignment of Mixer Valve Adapter PCB

		Voltage status: open	Voltage status: closed
X1	Actuator PCB		
X2	Safety (V27), USA version NC	0 V	approx. 23 V
X3	Safety-BI (V28), USA version NC	approx. +22 V	approx. −22 V
X4	Proportional valve (V10), see "Voltages at Proportional Valve (V10)"		
X5	Container flush (V7)	0 V	approx. 23 V
X6	Bellows light barrier (transmitter)		
X7	ZV3 (O_2)	approx. 23 V	0 V
X8	ZV1 (AIR)	approx. 23 V	0 V
X9	ZV2 (N_2O)	approx. 23 V	0 V

6.2.1 Voltages at Proportional Valve (V10)

V10 and Δ pfgf form a control loop. The voltage at V10 varies with the set flow and with the supply pressure in the container. To ensure a constant flow through V10 the trigger voltage is increased if the supply pressure Ptank decreases. If the supply pressure increases the trigger voltage is decreased accordingly.

To check the trigger voltage, proceed as follows:

Julian is switched off.

- Connect a voltmeter (parallel to V10) to X4 of the Adapter Mixing Valve PCB (see Fig. 11:).

CAUTION: Risk of short-circuit.

Use only small test terminals or test probes.

- Switch on Julian and start Service Mode.
- Remove breathing system.
- Set proportional valve V10 to 6 L.
- Fill container (e.g., open ZV AIR, set Ptank to 2.5 bar, close ZV AIR).
- Check that a voltage of approx. 16 V is present at proportional valve.
- As soon as container is empty, check that voltage at proportional valve has increased to approx. 24 V (V10 is fully opened).

7 Slot Valve Adapter PCB

7.1 Component Layout of Slot Valve Adapter PCB

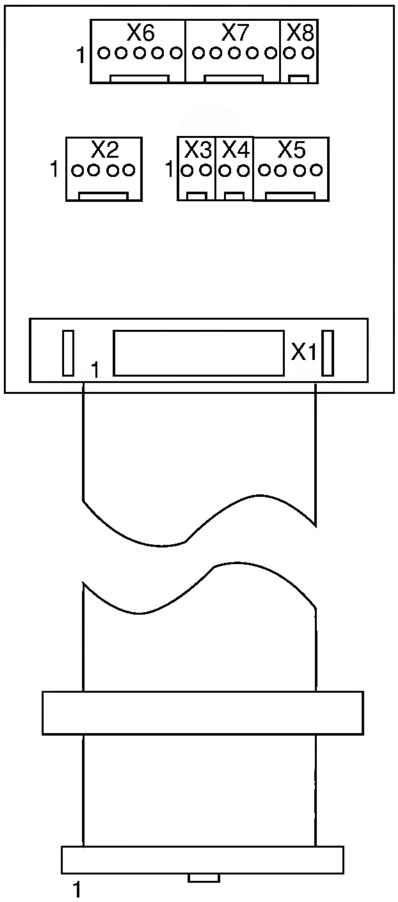


Fig. 12: Component layout of Slot Valve Adapter PCB

7.2 Connector Pin Assignment of Slot Valve Adapter PCB

X1	Actuator PCB
X2	PAV
X3	MV2 voltage, see "Voltage Supply to Ventilator Valves"
X4	MV3 voltage, see "Voltage Supply to Ventilator Valves"
X5	Stepper (stepper motor)
X6	LS1 (stepper motor)
X7	LS2 (stepper motor)
X8	PEEP

8 Ventdos Controller PCB

Carefully read and follow the message below when replacing the Ventdos Controller PCB.

Electrostatic discharge can damage electrostatic sensitive devices. Use a static-dissipative mat and a wrist strap when handling electrostatic sensitive devices.

8.1 Repair Instructions

– Not applicable –

8.2 Voltage Supply to Ventdos Controller PCB

See "Voltage Supply to Actuator PCB".

8.3 Component Layout of Ventdos Controller PCB

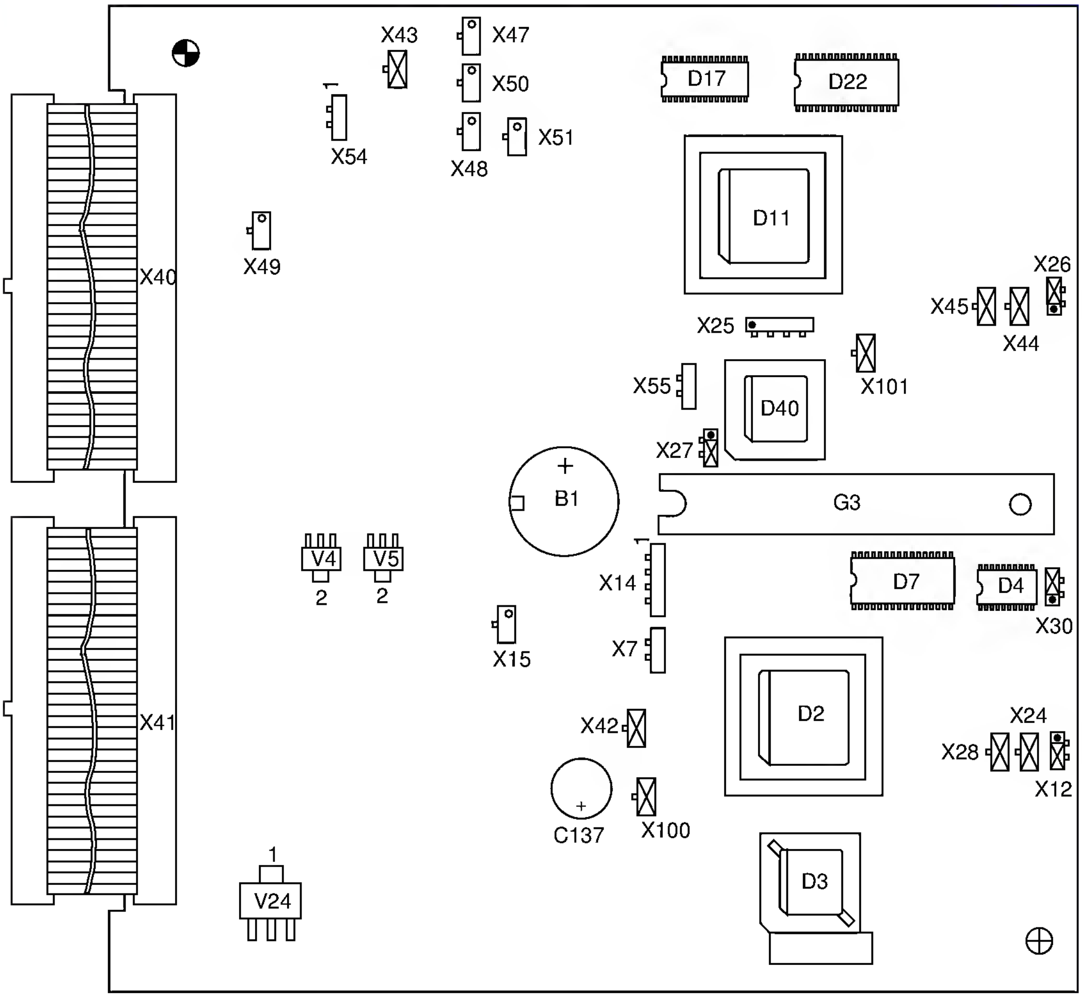


Fig. 13: Component Layout of Ventdos Controller PCB

8.4 Connector Pin Assignment of Ventdos Controller PCB

X14 RS232	
Pin	Assignment
1	+5 V
2	not assigned
3	RXD
4	TXD
5	DGND

X54 CAN	
Pin	Assignment
1	GND-ISO
2	CAN LO
3	CAN-HI

X40, 41, see Actuator PCB

8.5 Replacing Ventdos Controller PCB

- Switch off Julian.
- Remove rear panels.
- Pull out pneumatic plug-in unit.
- Remove EDOS block (see "Removing EDOS").
- Remove Actuator PCB (see "Replacing Actuator PCB").
- Remove Ventdos Controller PCB.

Risk of damage to the electronics due to reversed polarity. During installation, make sure the polarity and the plug-in connections are correct.

Risk of malfunction due to kinked or squeezed hoses. Make sure not to kink or squeeze any hoses when reassembling the unit.

- If no service contract exists for the Julian, install a lithium battery (1835343) on the new Ventdos-Controller PCB.
  If a service contract exists for the Julian, install the lithium battery from the dismounted PCB on the new Ventdos Controller PCB.
- Mount new Ventdos Controller PCB using reverse method of that used for dismounting old Ventdos Controller PCB.
- Check Julian according to relevant Test Certificate.

9 Pneumatic Plug-In Unit

9.1 Removing Pneumatic Plug-In Unit

Electrostatic discharge can damage electrostatic sensitive devices. Use a static-dissipative mat and a wrist strap when handling electrostatic sensitive devices.

- Switch off Julian.
- Disconnect pressure connections from gas supply system.
- Disconnect pressure connections from gas connection of Julian.
- Remove rear panels of Julian.
- Remove breathing system.
- Remove breathing system catch **A** (see detail Z).

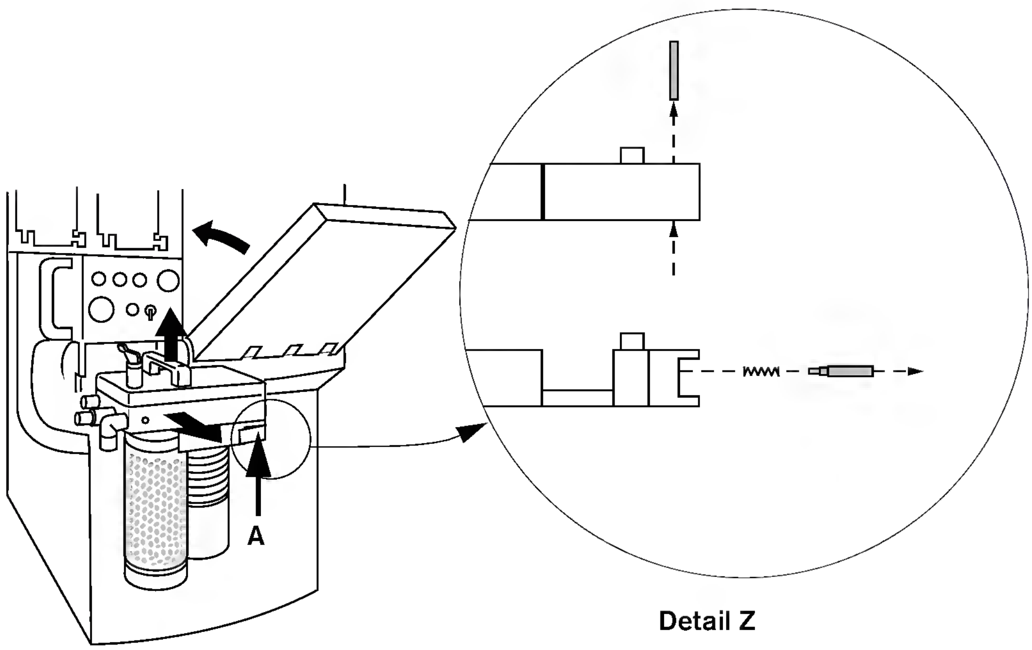


Fig. 14: Removing breathing system catch

- Remove hose **B** (if fitted).
- Remove hose **C**.
- Disconnect plug-in connection **D**.
- Disconnect plug-in connection **E**.
- Carefully pull out pneumatic plug-in unit as far as it will go.
- Remove hose **F** located behind anesthetic vaporizer plug-in system.
- Remove covers **G**.
- Remove hose **H** from secretion suction system.

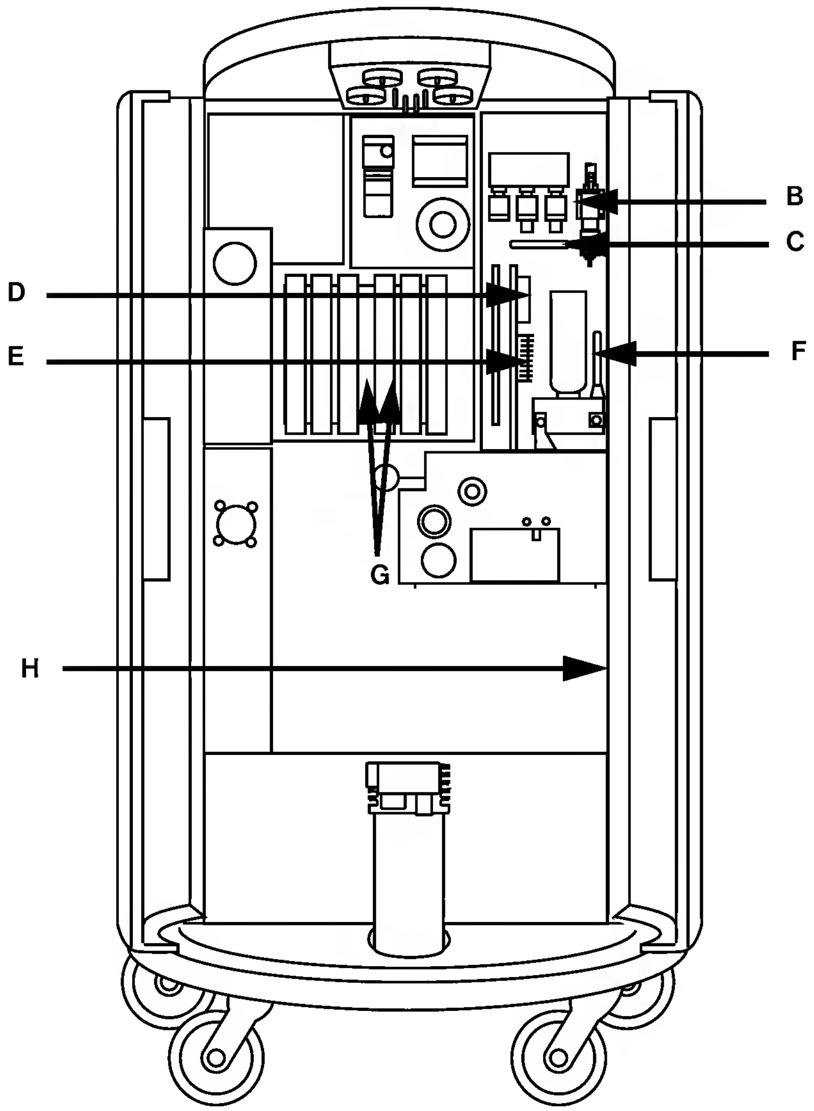


Fig. 15: Removing pneumatic plug-in unit (rear view)

- Disconnect plug-in connection **J** of flow sensor cable.
- Secure plug with a pull-through cable.
- Carefully pull flow sensor cable out of duct without pulling out pull-through cable.
- Remove pull-through cable from the plug.
- Loosen two screws **K**.

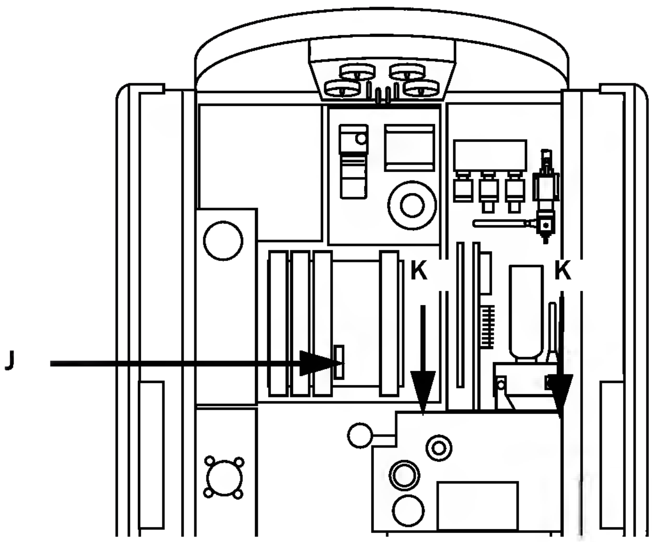


Fig. 16: Removing flow sensor cable plug-in connection

- Pull out pneumatic plug-in unit completely.
- Place pneumatic plug-in unit on appropriate surface.

Risk of malfunction due to kinked or squeezed hoses. Make sure not to kink or squeeze any hoses when reassembling the unit.

- Mount pneumatic plug-in unit using reverse method of that used for dismounting.
- Use pull-through cable to pull flow sensor cable through duct.

10 Adjusting the Safety Valve

The safety valve must be readjusted if the pressure values are outside the tolerance (see Test Certificate "Checking Pawv, Pawm and safety valve") or if the safety valve has been replaced with a new one. The safety valve is located next to the PEEP valve in Julian's pneumatic assembly.

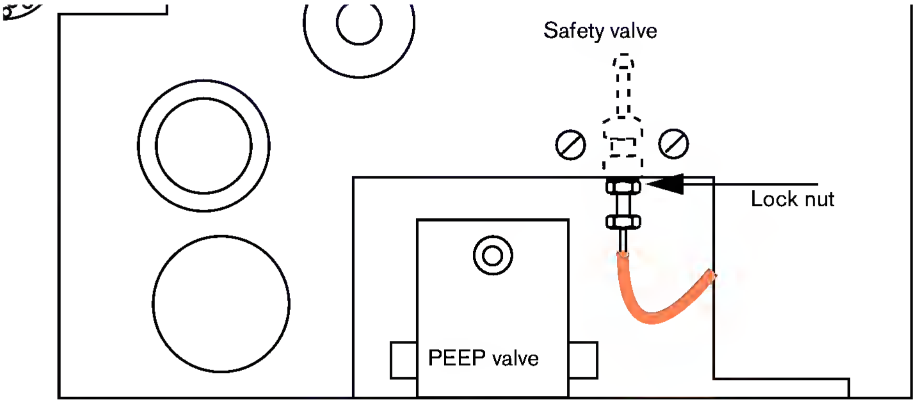


Fig. 17: Rear view of Julian

Safety valve adjustment and testing procedure:

- Seal Y-piece.
- Call up service mode menu "EDOS Test".
- Set V10 to 2 L/min.
- Open ZV AIR.
- Call up service mode menu "Ventilator Test".
- Set flow valve to 40 L/min.
- Set MV3 to "auto".
- Set MV1 to maximum.
- Open MV2.
- Loosen lock nut on safety valve.

- Using the safety valve, set the PawV pressure value to 82 mbar (80 to 84 mbar).

To adjust, turn the safety valve counter-clockwise (decreases the pressure value) or clockwise (increases the pressure value).

Make sure the breathing system bellows are at the bottom of the pressure chamber. If the breathing system bellows are not at the bottom of the pressure chamber, this may be due, for example, to a leakage (breathing system not fitted).

- Tighten lock nut to secure safety valve.
- Call up service mode menu "SpO2/Julian Ventilator EDOS".
- Call up test 23.

The displayed "psi pressure“ should be between 77 to 87 mbar.

- If the displayed "psi pressure“ is not between 77 to 87 mbar, re-adjust the safety valve.
- Re-assemble Julian ready for use.
- Perform safety check and function tests according to Test Certificate.

11 EDOS

11.1 Removing EDOS

Electrostatic discharge can damage electrostatic sensitive devices. Use a static-dissipative mat and a wrist strap when handling electrostatic sensitive devices.

- Switch off Julian.
- Remove rear panels.
- Pull out pneumatic plug-in unit.
- Remove container **A**.
- Remove screws **B**.
- Remove screw **C**.
- Lift up EDOS block in direction of **D**, and swivel it in direction of **E** and **F**.
- Remove EDOS block and secure it to **G** using screw **C**.

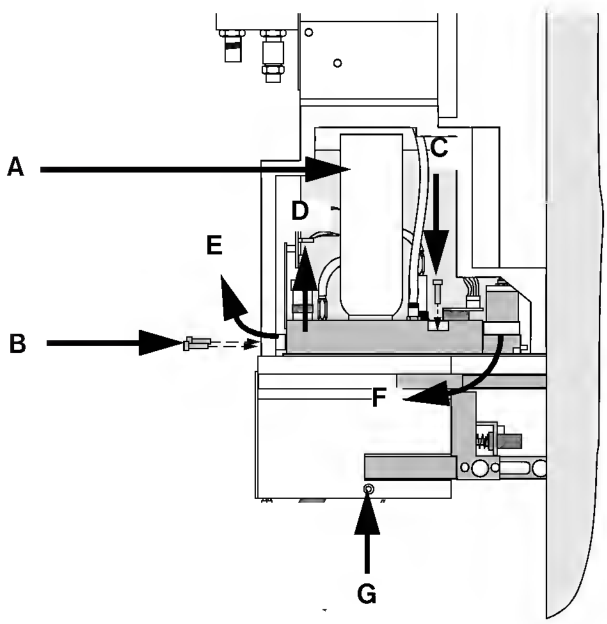


Fig. 18: Removing EDOS (side view)

Risk of damage to the electronics due to reversed polarity. During installation, make sure the polarity and the plug-in connections are correct.

Risk of malfunction due to kinked or squeezed hoses. Make sure not to kink or squeeze any hoses when reassembling the unit.

- Mount EDOS block using reverse method of that used for dismounting.
- Check Julian according to relevant Test Certificate.

11.2 Incorrect Assembly of Clippard 2/2-Way Valves (M32944)

When mounting or dismounting a Clippard 2/2-way valve take the following precautions:

Risk of unintentional change of valve flow values if knurled rings A (see Fig. 19:) are turned while mounting or dismounting Clippard 2/2-way valves.

Do not use knurled rings A as assembly aid. Use 3 mm holes B (see Fig. 19:) instead.

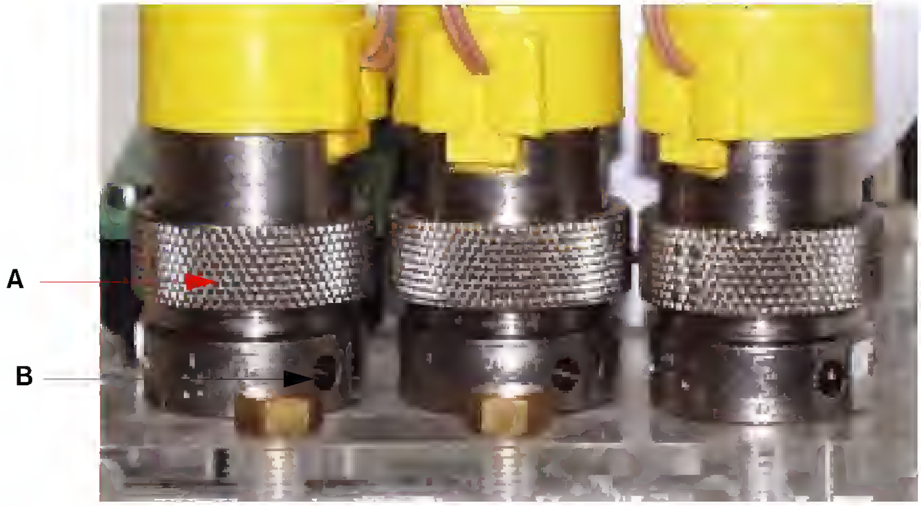


Fig. 19: Clippard 2/2-way valves

The knurled ring A **(see Fig. 19:) connects the upper part of the valve to the lower part of the valve.**

11.3 CS System Inlet Valves Flow Calibration

The flow through an open CS system inlet valve is calibrated to a defined value. If this value is outside tolerance, this may result in errors in the gas flow control or in the gas supply.

11.3.1 Fault Isolation

Check the CS system inlet valves in Extended Service Mode. Perform the following test steps for each of the CS system inlet valves:

- 1.) ZV1 (AIR), ZV2 (N2O), and ZV3 (O2) closed;
  V7 open;
  V10 open, 12 L/min
- 2.) If P_{tank} = ambient pressure, V7 closed.
- 3.) ZVx (AIR or N2O or O2) open.
  Count the increments until Ptank reaches 2500 mbar.
  Open only one valve at a time. Then continue with step 1.), empty the container, then check the second and the third valve.
- 4.) Compare the increments of the valves.
  At a CS system pressure of 5 bar, Ptank must reach 2500 mbar in 3 to 4 increments. If Ptank reaches 2500 mbar in less or more increments, the flow through the respective CS system inlet valve is outside tolerance. If the CS system pressure is < 5 bar, this results in a higher number of increments. Always compare the increments of all CS system valves. They must be nearly the same.

Replace a CS system inlet valve which is outside tolerance.

During repairing, refer to the repair information "Incorrect Assembly of Clippard 2/2-Way Valves (M32944)".

11.4 Blockage in EDOS Hose System

Do you suspect there may be a blockage in the EDOS block or a or partial blockage in the hose system? There may well be a blockage or a partial blockage between the breathing system and the restrictor (Dos2). Check this in Extended Service Mode.

- Connect the CS system;
  ZV1 (AIR) open;
  ZV2 (N2O) and ZV3 (O2) closed;
  V7 and V10 closed.
- First read the Psys pressure (side: VentEdos/ManSpont).
  Then set V10 to 12 L/min.
  Read the Psys pressure again.

If Psys increases by 100 mbar to 150 mbar, then the hose system or the flow resistance of the hose system is o.k. If Psys increases by considerably more than 150 mbar, then there is a blockage or a partial blockage in the hose system.

- Check whether the fresh-gas hose between the EDOS block and the anesthetic vaporizer plug-in system is buckled when the pneumatic plug-in unit is fitted.
- Pull out the breathing system and check whether the blockage is still present. If not, the problem may lie in the absorber element. Check that part of the absorber element that projects into the double seal of the respiratory gas block. The gap into which the fresh gas is piped in might be damaged.

11.5 EDOS Leak Test

Check for leaks in Extended Service Mode as follows:

- Connect the AIR, O2, and N2O gas supplies.
ZV1 (AIR), ZV2 (N2O), ZV3 (O2) –> closed;
V10Prop –> closed;
V7 open for venting, then closed.

Test 1

- Open ZV1 (AIR) shortly and close again.

Ptank must reach a value below 2500 mbar (e.g. 2000 mbar). If necessary, open V10 to reduce pressure until Ptank is in the display range of approx. 2000 mbar.

.

Table 2: Test 1 results

Observation	Conclusion or further procedure	Remedy
Ptank is almost constant after approx. 4 to 7 increments.	No leak in the container system. A leak rate of 50 mbar/min is within tolerance.	Not applicable.
Ptank decreases continually (> 50 mbar/min)	1.) V7 is leaky 2.) Pressure sensor ΔPfgf has drifted (ΔPfgf and V10 are part of the same control loop). 3.) V10 is leaky.	Replace individual components. If no gas supply is connected, there also may be a leak in the respective CS system valve.
Ptank increases continually.	One of the CS system valves is leaky. –> Perform test 2.	See test 2

Test 2

- Connect only **one** CS system gas source (for example, AIR); first V7 –> open; V10 –> closed; open CS system valves that are not supplied with gas from the CS system shortly and close them again (venting); V7 –>closed.

If Ptank increases, the selected CS system valve is defective and must be replaced.
Carry out this test on each CS inlet.

12 Flow Sensor Cable

12.1 Replacing Flow Sensor Cable

Electrostatic discharge can damage electrostatic sensitive devices. Use a static-dissipative mat and a wrist strap when handling electrostatic sensitive devices.

- Switch off Julian.
- Remove pneumatic plug-in unit completely (see "Removing Pneumatic Plug-In Unit").
- Remove screws **A**.
- Remove screws **B**.
- Remove mounting plate **C**.
- Remove flow sensor cable.

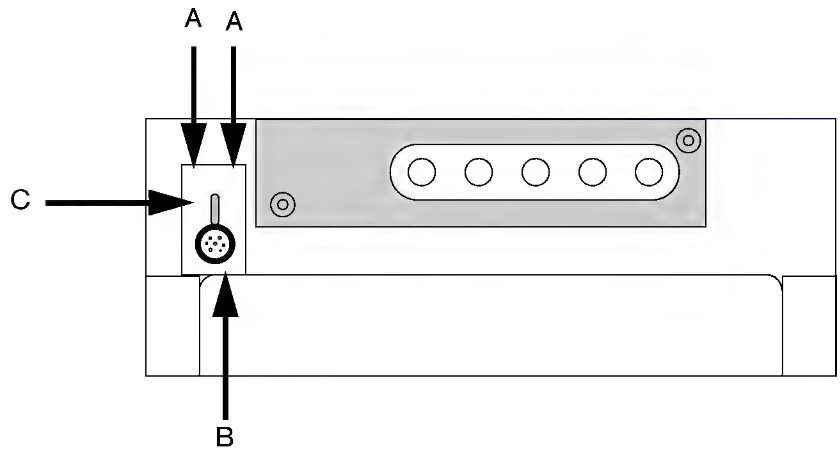


Fig. 20: Julian interface

Risk of damage to the electronics due to reversed polarity. During installation, make sure the polarity and the plug-in connections are correct.

Risk of malfunction due to kinked or squeezed hoses. Make sure not to kink or squeeze any hoses when reassembling the unit.

- Mount new flow sensor cable using reverse method of that used for removing old flow sensor.
- Check Julian according to relevant Test Certificate.

13 Heater

13.1 Replacing Heater

Electrostatic discharge can damage electrostatic sensitive devices. Use a static-dissipative mat and a wrist strap when handling electrostatic sensitive devices.

- Switch off Julian.
- Remove rear panels.
- Remove complete pneumatic plug-in unit (see "Removing Pneumatic Plug-In Unit").
- Remove EDOS block (see "Removing EDOS").
- Remove spring washers **A**.
- Disconnect heater connector from Actuator PCB.
- Remove heater.

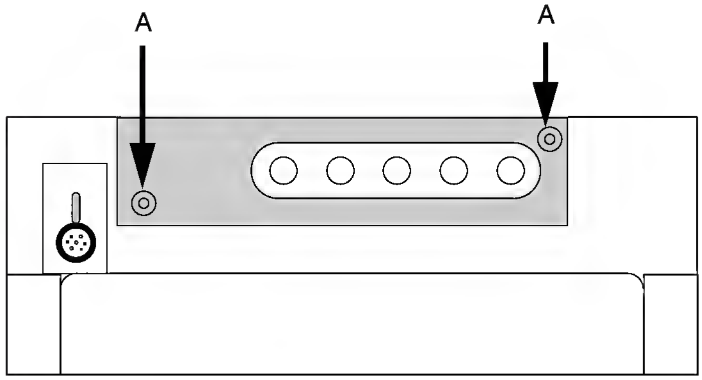


Fig. 21: Julian heater

Risk of damage to the electronics due to reversed polarity. During installation, make sure the polarity and the plug-in connections are correct.

Risk of malfunction due to kinked or squeezed hoses. Make sure not to kink or squeeze any hoses when reassembling the unit.

- Mount new heater using reverse method of that used for dismounting old heater.
- Check Julian according to relevant Test Certificate.

14 PEEP Valve

14.1 Replacing PEEP Valve

Electrostatic discharge can damage electrostatic sensitive devices. Use a static-dissipative mat and a wrist strap when handling electrostatic sensitive devices.

- Switch off Julian.
- Remove rear panels .
- Pull out pneumatic plug-in unit.
- Loosen screws **A**.
- Push bottom cover in direction of **1**.
- Swivel bottom cover in direction of **2**.
- Disconnect hoses from the PEEP valve.

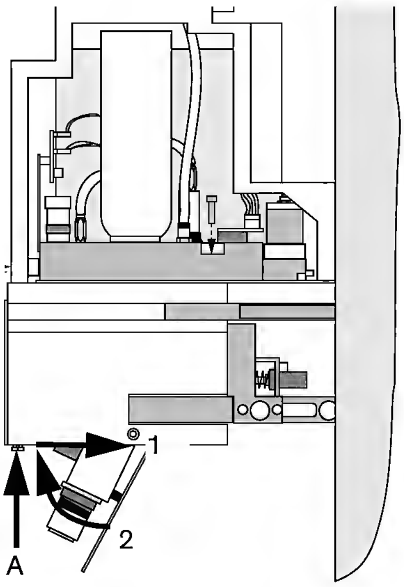


Fig. 22: Replacing PEEP valve (side view)

- Remove screws **B**.
- Remove PEEP valve.

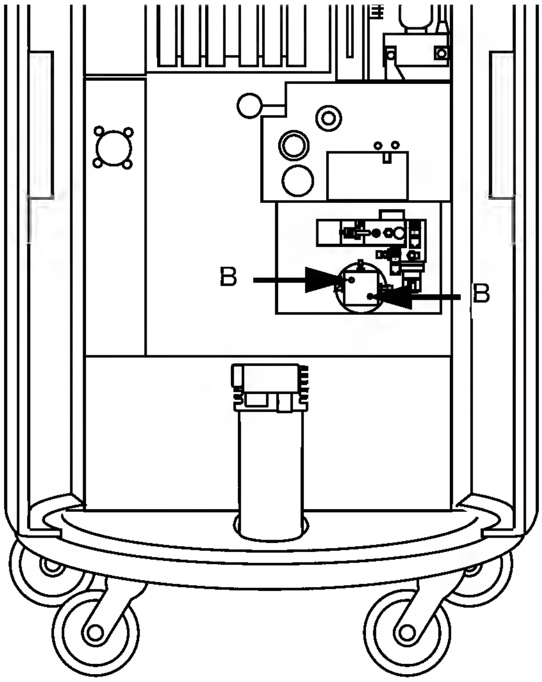


Fig. 23: Replacing PEEP valve (rear view)

Risk of damage to the electronics due to reversed polarity. During installation, make sure the polarity and the plug-in connections are correct.

Risk of malfunction due to kinked or squeezed hoses. Make sure not to kink or squeeze any hoses when reassembling the unit.

- Mount new PEEP valve using reverse method of that used for dismounting.
- Check Julian according to relevant Test Certificate.

14.2 Offset Calibration of PEEP Valve in Case of Fault in Test Step 18

With software 3.02 or higher, problems may occur in test step 18 (PEEP valve test) (master code MA 0 0 6 4 0 is generated), especially in higher altitudes.

Cause: The PEEP valve test at 20 mbar is outside the permissible tolerance of ± 4 mbar.

14.2.1 Calibrating the PEEP Valve

- Remove the rear panel of Julian and connect O2 pipeline supply.
- Switch on Julian , acknowledge check list and call up Extended Service Mode.
- Wait approx. 30 s. for the slot valve to be referenced.
- Call up service page "VentEDOS".
- Close Y-piece and start service test 33 "Y-piece test".
- Open Y-piece.
- Start service test 28 "Pressure sensor calibration". Test is completed without faults - MA 0 0 0 2.
- Close Y-piece.
- Call up "EDOS test" via Man/Spont key.
- Open ZV O2 and set V10 to 0.1 L/min.
- Start "Ventilator test" via IPPV key.
- Read out Pvor.
- MV2 in position "open". Pressure increase of Pvor is 1.8 ± 0.1 bar. If necessary, re-adjust on PEEP valve using pressure regulator of ventilator.
- MV3 in position "auto".
- Set MV1 to 20 mbar. Pressure reading of PawM and PawV is 20 ± 2 mbar.
- Calibrate pressure value using slot screw underneath PEEP valve. You do not need to remove the PEEP valve. The ventilator chassis has a borehole for this purpose. After calibrating, secure slot screw with screw stop varnish.

14.2.2 Checking the PEEP

– Set MV1 to 0 mbar. Pressure reading of PawM and PawV is 0 ± 2 mbar.

– Set MV1 to 40 mbar. Pressure reading of PawM and PawV is 40 ± 4 mbar.

– Set MV1 to 0 mbar. MV3 in position "man". MV2 in position "closed".

– Call up "EDOS test". ZV O2 in position "closed". Set V10 to 0 L/min.

– Call up service menu "VentEDOS" and start service test 18. Test is completed without faults - MA 0 0 0 2.

– Mount rear panel of Julian. Perform safety tests. Allow self-test to complete, then carry out function test according to Test Certificate.

15 Slot Valve

15.1 Replacing Slot Valve

Electrostatic discharge can damage electrostatic sensitive devices. Use a static-dissipative mat and a wrist strap when handling electrostatic sensitive devices.

- Switch off Julian.
- Remove rear panels.
- Swivel down bottom cover (see "Replacing PEEP Valve").
- Disconnect hose from slot valve.
- Disconnect ribbon cable which leads to Actuator PCB from slot valve assembly.
- Disconnect connectors of PEEP, MV3, and MV2 valves.
- Remove screw **B** including ground cable.
- Remove lateral screws of slot valve (located behind pressure regulator)
- Remove slot valve.

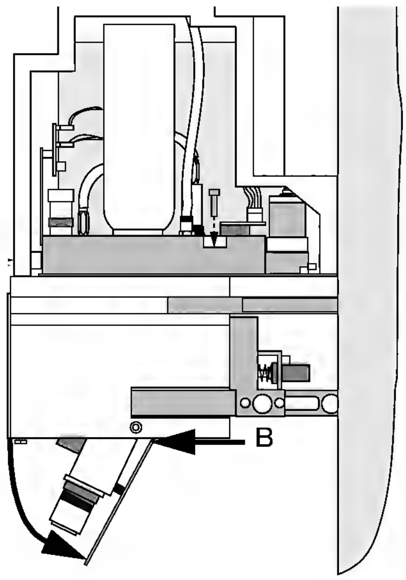


Fig. 24: Replacing the slot valve (side view)

Risk of damage to the electronics due to reversed polarity. During installation, make sure the polarity and the plug-in connections are correct.

Risk of malfunction due to kinked or squeezed hoses. Make sure not to kink or squeeze any hoses when reassembling the unit.

- Mount new slot valve using reverse method of that used for dismounting.
- Check Julian according to relevant Test Certificate.

16 Gas Inlet Block

16.1 Replacing Gas Inlet Block

Electrostatic discharge can damage electrostatic sensitive devices. Use a static-dissipative mat and a wrist strap when handling electrostatic sensitive devices.

- Switch off Julian.
- Remove rear panels.
- Pull out pneumatic plug-in unit.
- Remove hoses from gas inlet block.
- Remove screws **A**.
- Pull gas inlet block in direction of **1**.
- Swivel gas inlet block in direction of **2**.
- Turn gas inlet block in direction of **3**.
- Remove gas inlet block.

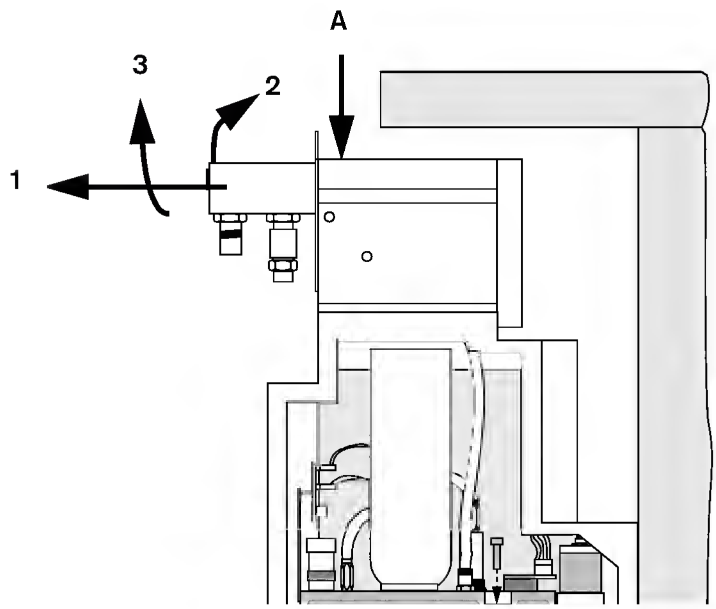


Fig. 25: Replacing gas inlet block (side view)

Risk of malfunction due to kinked or squeezed hoses. Make sure not to kink or squeeze any hoses when reassembling the unit.

- Mount new gas inlet block using reverse method of that used for dismounting the old gas inlet block.
- Check Julian according to relevant Test Certificate.

16.2 Mounting New Non-return Valves on the Gas Inlet Block

Cap set (cuff + cap) MX08020

If the non-return valve is leaky, it is necessary to mount the cuff (1) and the flow cap (2) (new) on the gas inlet insert (see the following illustration).

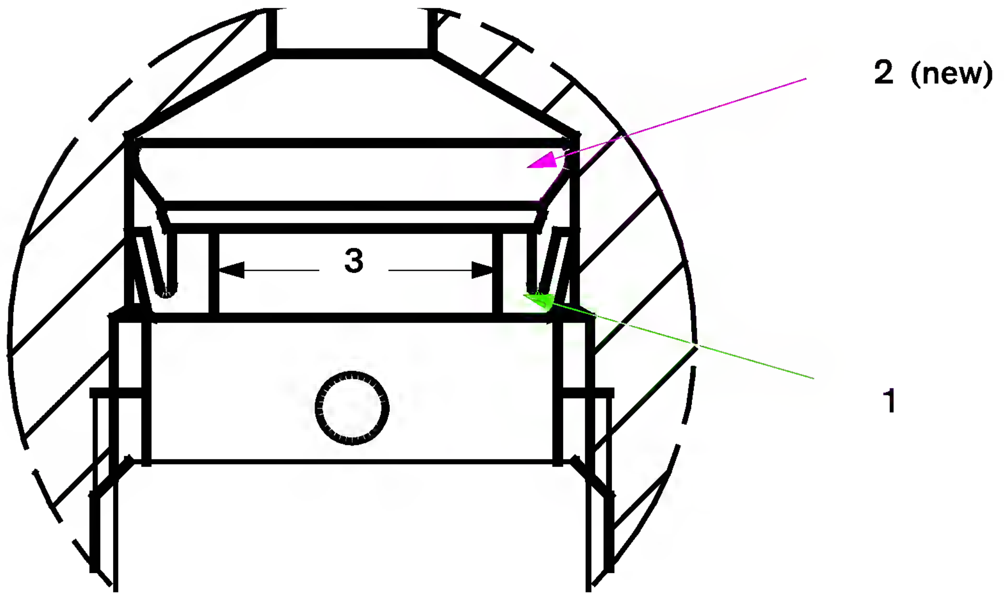


Fig. 26: Sectional view of NIST, DISS connectors (end piece) in the gas inlet block

16.2.1 Mounting the Cuff AF00220

Procedure:

- Apply Oxygenoex S4 7901580 on the recess (3, see Fig. 26:) of the gas inlet insert.

Make sure the cuff is positioned correctly.

- Place the cuff on your thumb and push the gas inlet insert into the cuff (while turning the gas inlet insert).
- As soon as the cuff fits properly in the recess, turn the cuff 5 times over its full circumference (to spread the grease evenly).
- Wipe away any residual grease above or below the cuff using a cloth.

16.2.2 Mounting the Flow Cap

- Press the flow cap onto the end of the gas inlet insert. The flow cap must engage properly.
- The flow cap must be located parallel to the edge of the recess.

16.2.3 Screwing the Gas Inlet Insert into the Gas Inlet Block

- Check whether the O-ring on the gas inlet insert can be re-used.
- Before screwing in the gas inlet insert, apply alcohol or disinfection agent Desderman (7901292) on the lip seal of the cuff in order be able to insert the cuff more easily.
- Tighten the gas inlet insert using a torque of 24 ±2 Nm
- If a NIST-DIN adapter is fitted, tighten it using a torque of 9 Nm.

16.2.4 Final Tests

- Perform gas type and leak tests according to Test Certificate (test steps 7. through 9.).

16.3 Checking Non-return Valves (AF00220) for Cylinder Supply in Gas Inlet Block

In units with cylinder supply, the sleeve of the cylinder non-return valve might turn over. In this case the gas flow would be interrupted. Check proper functioning of sleeves as follows:

- Disconnect Julian from pipeline system.
- Make sure O_2 and N_2O are connected.
- Call up Service Mode; page "Vent EDOS / EDOS Test".

Check the sleeve for the O_2 cylinder first:

- Set O_2 pipeline valve to "open".
- Set V7 to "open".
- Open O_2 cylinder as fast as possible (one turn is sufficient). This produces a fast increase in flow.

A gas flow should be audible. If a gas flow cannot be heard, the sleeve has turned over and is blocking the gas flow.

Checking the sleeve for the N_2O cylinder.

- Set O_2 pipeline valve to "closed".
- Set N_2O pipeline to "open".
- Set V7 to "open".
- Open N_2O cylinder as fast as possible (one turn is sufficient). This produces a fast increase in flow.

A gas flow should be audible. If a gas flow cannot be heard, the sleeve has turned over and is blocking the gas flow.

- Close N_2O pipeline valve and V7.

If one of the sleeves has turned over, you need to replace all sleeves in order to avoid different change revisions in the gas inlet block. Install the new sleeve with flow cap (cap set MX08020).

Follow instructions under 16.2 "Mounting New Non-return Valves on the Gas Inlet Block"**.**

The cap set MX08020 includes one sleeve AF00220 and one flow cap 8602864. For a complete replacement of sleeves in the gas inlet block you will need 5 cap sets MX08020.

17 A-Cone (Optional)

17.1 Replacing A-Cone

Electrostatic discharge can damage electrostatic sensitive devices. Use a static-dissipative mat and a wrist strap when handling electrostatic sensitive devices.

- Switch off Julian.
- Remove rear panels.
- Pull out pneumatic plug-in unit.
- Remove gas inlet block (see "Replacing Gas Inlet Block").
- Disconnect hoses from A-cone.
- Remove screws **A**.
- Remove A-cone.

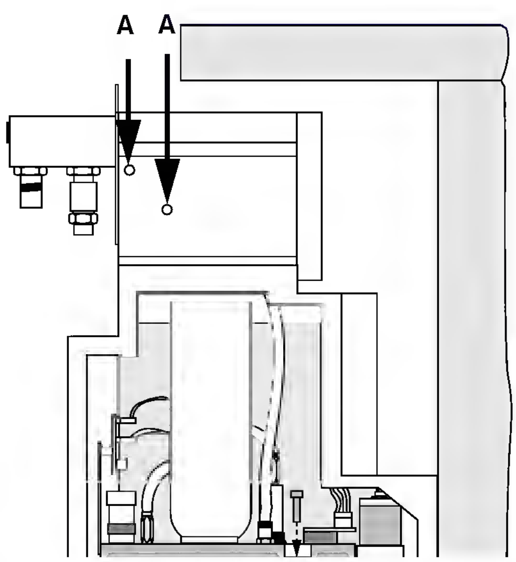


Fig. 27: Replacing A-cone (side view)

Risk of malfunction due to kinked or squeezed hoses. Make sure not to kink or squeeze any hoses when reassembling the unit.

- Mount new A-cone using reverse method of that used for dismounting old A-cone.
- Check Julian according to relevant Test Certificate.

18 Gas Inlet Block Overview

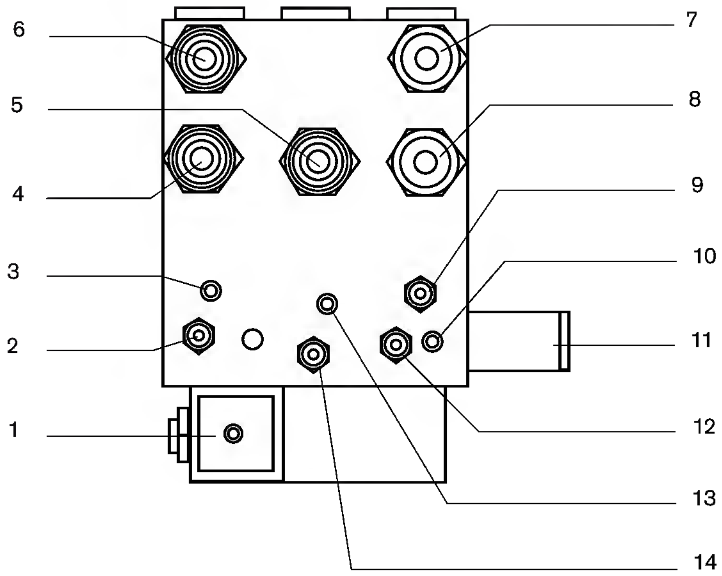


Fig. 28: Gas inlet block

Legend

1	MV5 valve	8	O_2 central supply system inlet
2	N_2O outlet	9	O_2 outlet
3	N_2O pressure gauge	10	O_2 pressure gauge
4	N_2O central supply system inlet	11	Pressure sensor (P_{AIR})
5	AIR central supply system inlet	12	Control pressure
6	N_2O cylinder supply inlet	13	AIR pressure gauge
7	O_2 cylinder supply inlet	14	AIR outlet

19 EDOS (Electronic Flow Control System) Overview

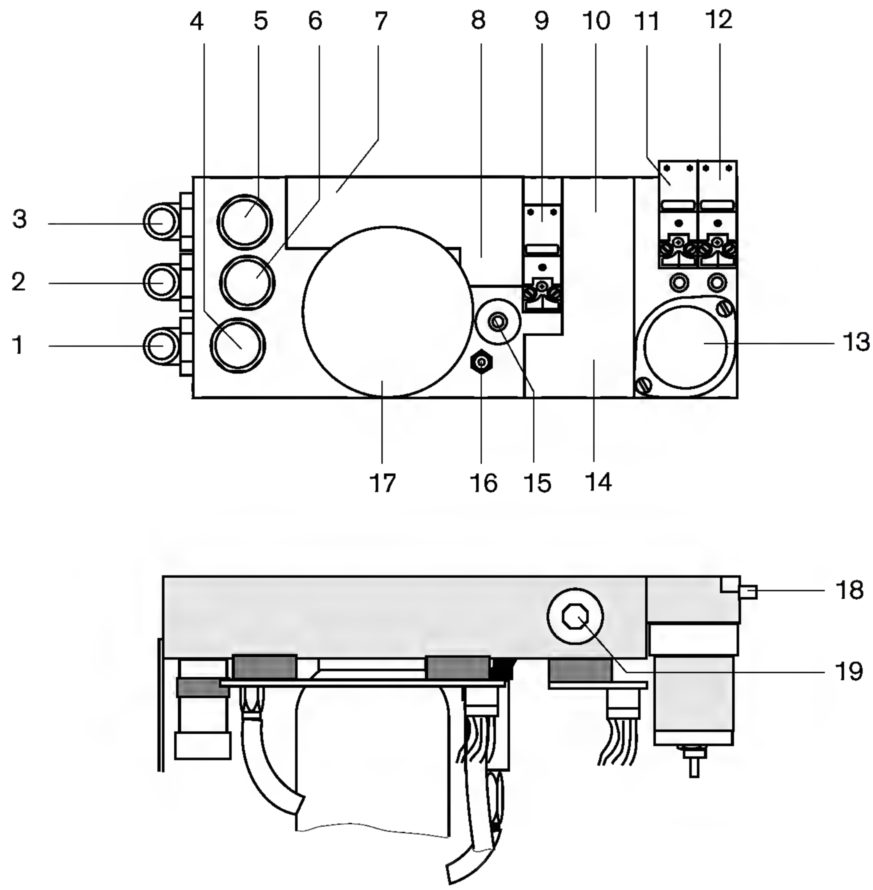


Fig. 29: EDOS (electronic flow control system)

Legend

1	O_2 inlet	11	V28 valve
2	AIR inlet	12	V27 valve
3	N_2O inlet	13	Pressure regulator
4	ZV3 (O_2) valve	14	Pressure sensor (P_{sys})
5	ZV2 (N_2O) valve	15	V7 valve
6	ZV1 (AIR) valve	16	(Anesthetic vaporizer plug-in system) outlet
7	Pressure sensor (P_{mix})	17	Reservoir
8	Pressure sensor (P_{res})	18	Adjustable restrictor (R2)
9	V10 valve	19	Screw plug with screen insert (Restr. 2)
10	Pressure sensor (P_{fgf})		

20 Interface Overview

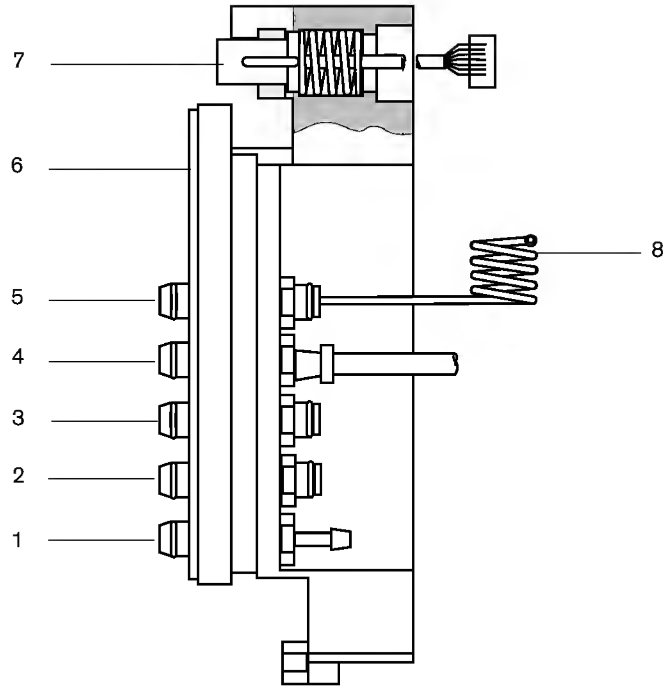


Fig. 30:Interface

Legend

1	PEEP	5	Pressure gauge
2	MV3	6	Heater
3	Control pressure	7	Flow sensor
4	Fresh gas	8	Microbial channel

20.1 Pneumatic Interface Repair Info

20.1.1 Leaks at the Pneumatic Interface

Problem:

Leaks may occur sporadically at the pneumatic interface between breathing system and Julian in units with serial nos. ARLM-XXXX, ARLN-XXXX, and ARMA-XXXX.

These leaks may cause the following errors:

- Error in self-test step 33
- Major leakages during the leak test
- No pressure buildup during operation

Testing: Breathing system interface (AF 00518)

- Make sure Julian is in IPPV mode.
- Connect test lung.
- Make sure default parameters are set.

Move breathing system slightly via the patient tubing. Do not use too much force in order to avoid irreversible damage to the patient system locking mechanism.

You should not hear a hissing sound, the measured VT should not decrease.

In case of malfunction, install interface conversion kit AF 00518.

Remedy:

- See conversion instructions to Interface AF00518 conversion kit. The sockets included in this conversion kit are longer than those fitted in the above mentioned device lot. Therefore they seal the breathing system more efficiently.

21 Slot Valve Overview

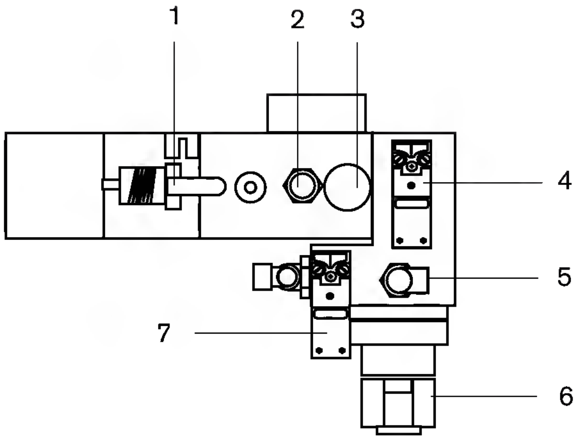


Fig. 31: Slot valve

Legend

1	Light barrier	5	Inlet
2	Outlet	6	Pressure regulator
3	Pressure sensor (P_{high})	7	MV3 valve
4	MV2/V2 valve		

22 Breathing System Overview

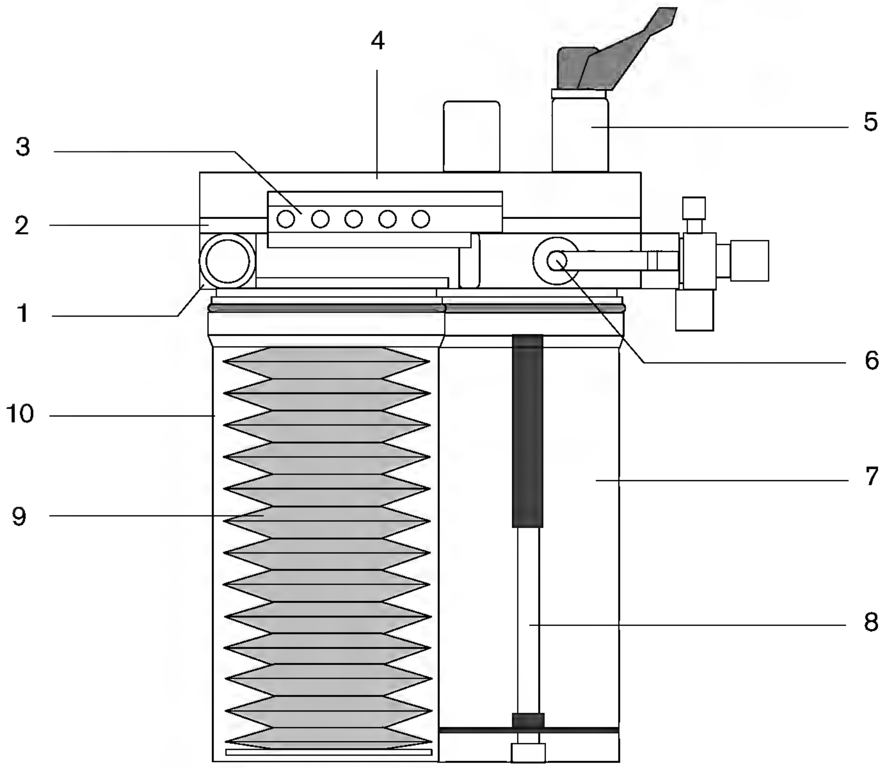


Fig. 32: Breathing system, complete

Legend

1	Respiratory gas block	6	Flow sensor
2	Valve plate	7	Absorber canister
3	Connector block	8	Absorber insert
4	Valve cover	9	Bellows
5	APL valve	10	Pressure chamber

22.1 Breathing System Faults

Table 3: Fault/Cause/Remedy

<table>
<tr><th>Fault</th><th>Cause</th><th>Remedy</th></tr>
<tr><td>Gas concentration in breathing system is too low.</td><td rowspan="3">Leak in bellows or in RV1 (M33832) of breathing system.

During inspiration, driving gas (normally AIR) flows into the circle system where it mixes with patient gas.

O_2 concentration decreases or, if the ventilator is powered with O_2, increases.

The bellows does not ascend as specified (depending on leak rate).

In the event of a major leak, the bellows moves only a little or not at all. The bellows does not move out of the light barrier. This causes the error in self-test step 31 (bellows light barrier).</td><td rowspan="3">If O_2 concentration is too low, interrupt AIR pipeline supply. The ventilator should continue working with O_2. If O_2 concentration increases, driving gas is flowing into the circle system.

If the ventilator is being powered with O_2 and O_2 concentration is too high, re-establish AIR pipeline supply.

• Inspect the bellows : If there is no visual damage, check RV1. RV1 function test: Julian is in IPPV mode. connect test lung.

Set the following parameters:

• Fresh gas: 9 L/min
Pmax: 70 mbar
Frequency: 12/min
TIP:TI: 0
PEEP: 5 mbar
Vt: 600 mL/min
TI:TE: 2:1

Observe movement of bellows for about 10 strokes. The bellows should always detach from the base of the bellows container. The length of stroke should not decrease. Otherwise replace RV1. RV1 was re-designed in June 1999. The material of the valve disc used in the new check valve M33832 has been changed. The valve discs are black now (used to be red).</td></tr>
<tr><td>Bellows does not ascend.</td></tr>
<tr><td>Error in self-test step 31 "Faulty bellows light barrier" (provided that hardware for bellows light barrier is fitted).</td></tr>
</table>

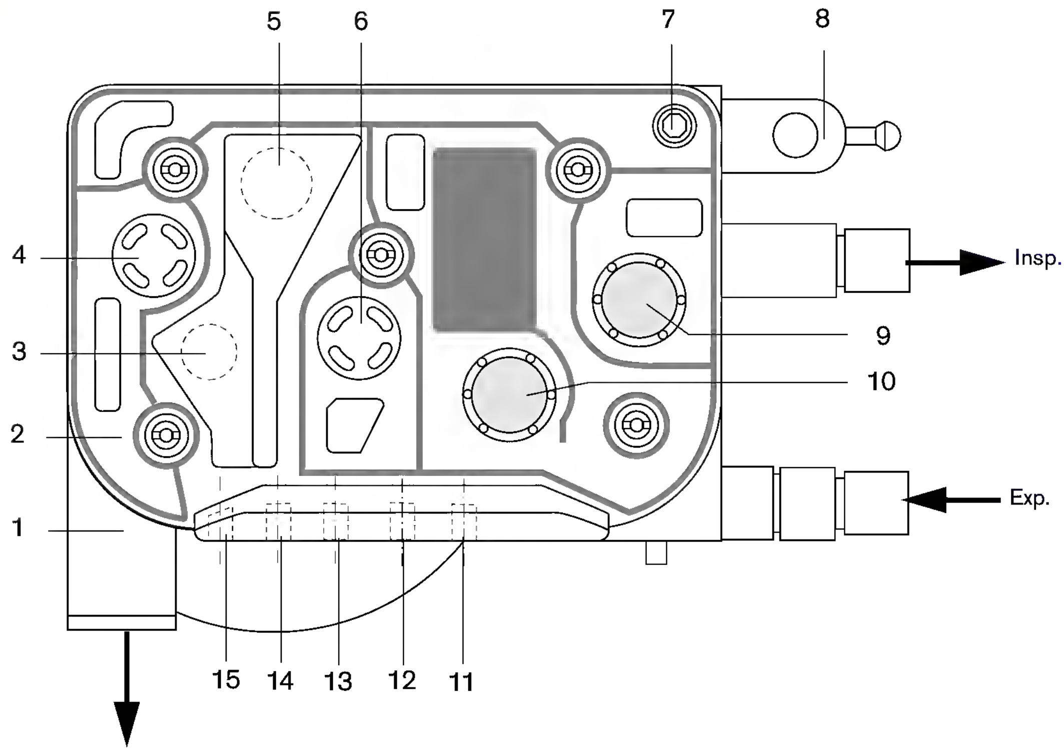


Fig. 33: Breathing system, open (valve plate)

Legend

1	Respiratory gas block	9	Inspiratory valve
2	Valve plate	10	Expiratory valve
3	PEEP valve (V1)	11	Pressure measurement channel
4	Check valve (RV2)	12	Fresh-gas channel
5	MAN/SPONT changeover valve (V4)	13	Driving gas channel
6	Check valve (RV1)	14	V4 control channel
7	APL valve crater	15	PEEP/P_{max} control channel
8	Breathing bag connector		

23 Pressure Regulator

23.1 Service Strategy for Repairs

	Documentation	Work performed
On-site repair	Microfiche Test Certificate	1. Replacement of components 2. Testing as per Test Certificate (Section on high-pressure accessory set)
On-site replacement	Microfiche Test Certificate	1. Replacement of entire pressure regulator 2. Testing as per Test Certificate (Section on high-pressure accessory set)

23.2 Repair Instructions

Fault	Test	Repair
Leakage at high-pressure connection	Check O-ring seat for contamination, chips and dimensional accuracy.	Replace O-ring of connecting pin.
Leakage at PIN-indexed connection	Check flat-gasket seat for contamination, chips and dimensional accuracy.	Replace flat gasket of pin-indexed connection
Leakage at pressure-gauge connection	Check nylon seal seat for contamination, chips and dimensional accuracy.	Replace nylon seal.
Leakage at connecting hose	Check pressure-gauge seal seat for contamination, chips and dimensional accuracy.	Replace pressure-gauge seal.
Leakage at seal G3/8" or M10 x 1	Check nylon seal seat for contamination, chips and dimensional accuracy.	Replace nylon seal.
Insufficient delivery pressure	Check diaphragm valve for contamination, chips and dimensional accuracy. Visually check spring.	Replace diaphragm valve including O-ring. Replace spring.
Excessive delivery pressure	Check diaphragm valve for contamination, chips and dimensional accuracy.	Replace diaphragm valve including O-ring.

Insufficient output capacity	Leak test at high-pressure connection, pressure-gauge connection or connecting hose. If no leak found:	Refer to information about removal of leakages. Replace sintered-metal screen insert.
Subsequent increase in pressure	Check diaphragm valve for contamination, chips and dimensional accuracy.	Replace diaphragm valve including O-ring.
Pressure-gauge pointer sticks	Visual check pressure gauge when opening/closing the cylinder valve with connecting hose open.	Replace pressure gauge.
Safety valve does not open at specified pressure	Check safety valve as per Test Certificate.	Replace safety valve.

24 Electronics

Contents

25 Service Strategy

	Testing	Repair
Inspection	Test Certificate	Minor repair Sensor replacement Tubing Fuses Battery
On-site repair	Test Certificate Service Mode	Assembly replacement Calibration where appropriate
Branch/Agency (workshop)	Test Certificate Service Mode	Assembly replacement Calibration where appropriate
Lübeck (workshop)	Test Certificate Service Mode Design documentation	Repair at component level

Read and observe the following message before opening the machine:

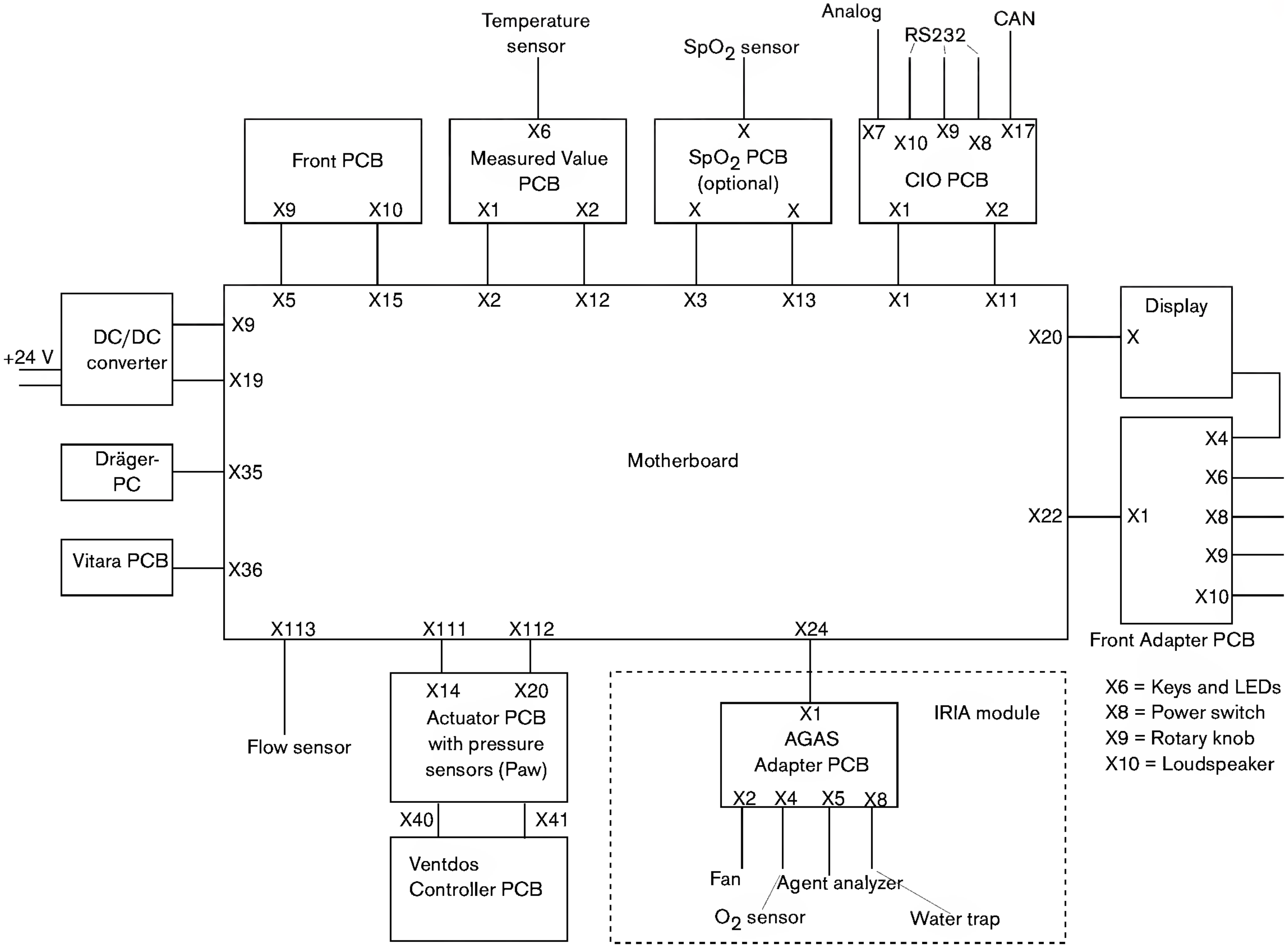
Electrostatic discharge can damage electrostatic sensitive components. Use a static-dissipative mat and a wrist strap when handling electrostatic sensitive components.

Read and observe the following message when replacing batteries, sensors etc.:

O_2 sensor and batteries are special waste.
Dispose of O_2 sensors and batteries according to local waste disposal regulations.

The connector assignments only list the most important connections.

Fig. 34: Connectors



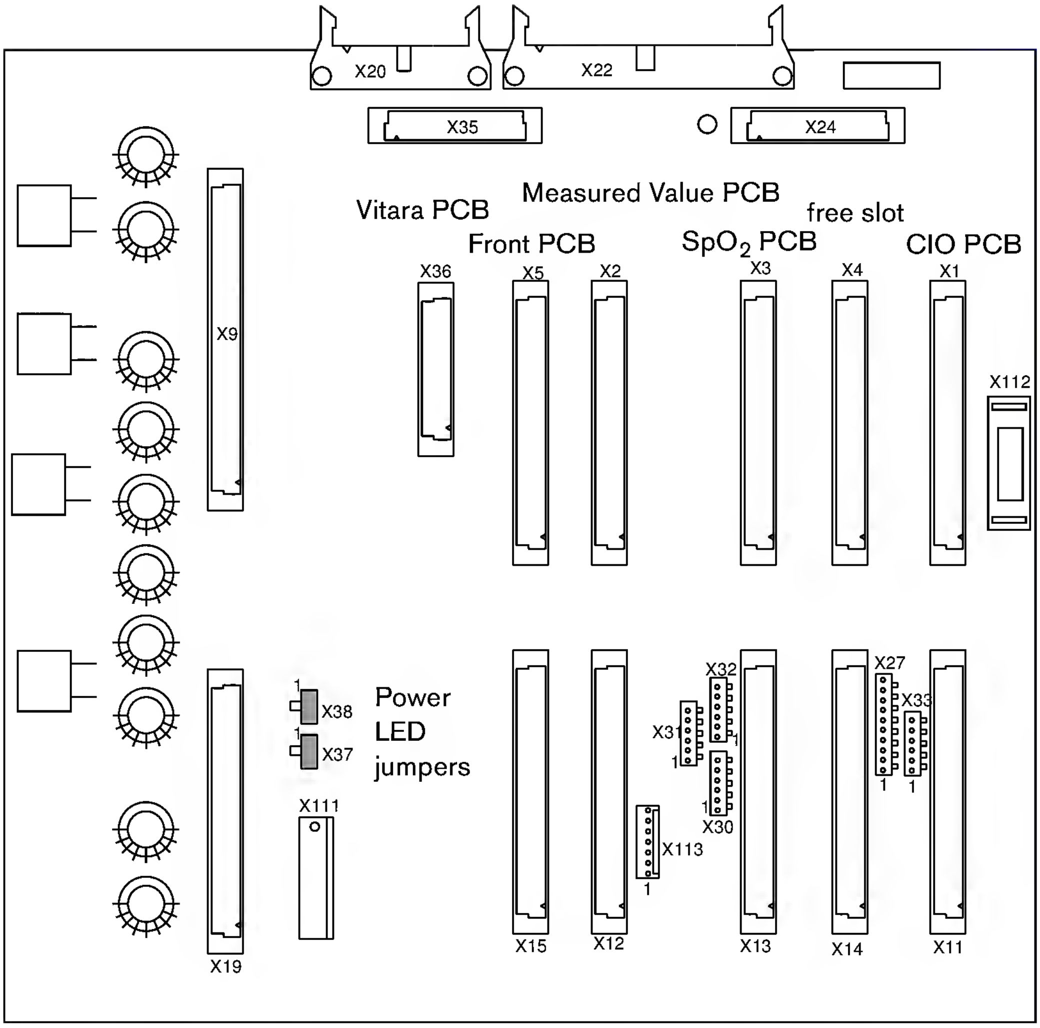


Fig. 35: Motherboard component layout diagram

26.1 Voltages at Connectors X4, X14, and X36

X4		X14	
1A/C, 2A/C	DGND	1A/C	AGND
31A/C, 32A/C	+5,15 V ±0.15 V	2A/C	+15 V ±0.5 V
		3A/C	–15 V ±0.5 V
		4A/C	12VGND
X36		5A/C	+12 V ±0.5 V
1A/C, 2A/C, 3A/C	+24 V ±1 V		
4A/C, 5A/C, 6A/C	24VGND		

27 CIO PCB

Electrostatic discharge may damage electrostatic sensitive devices. **Always use a static-dissipative mat and a wrist strap** when handling electrostatic sensitive devices.

27.1 CIO PCB Power Supply

X1 (motherboard)	
Pin	Assignment
1/2 c	DGND
31/32 c	+5 V

27.2 CIO PCB Connector Pin Assignment

27.2.1 RS232 Interface, Agent Analyzer

X11 (motherboard)	
Pin	Assignment
7 a	TXDANQ
8 a	RTSANQ
7 c	RXDANQ
8 c	CTSANQ

27.2.2 Debug Interface

X3	
Pin	Assignment
1	+5 V
2	NC
3	DebugRX (RXD)
4	DebugTX (TXD)
5	DGND

X6 (background debug)	
Pin	Assignment
1/3	DGND
2	BKPT
4	FREEZE
5	CPURESETQ
6	TFETCH
7	VBDM
8	IPIPE

27.2.3 Analog Interface

X7	
Pin	Assignment
1/4/7	FGND
2	Trigger 2
3	Analog 2
5	Trigger 1
6	Analog 1
8	Trigger 0
9	Analog 0

27.2.4 RS232 Interfaces

X8	X9	X10	Signal
Pin	Pin	Pin	Assignment
2	2	2	TXD
3	3	3	RXD
5	5	5	FGND

27.2.5 CAN Interface

X16	
Pin	Assignment
1/2	CANH
3	CANL

X17	
Pin	Assignment
1/4/5/8/9	NC
2	CANL
3/6	GNDCAN
7	CANH

27.3 CIO PCB Component Layout Diagram

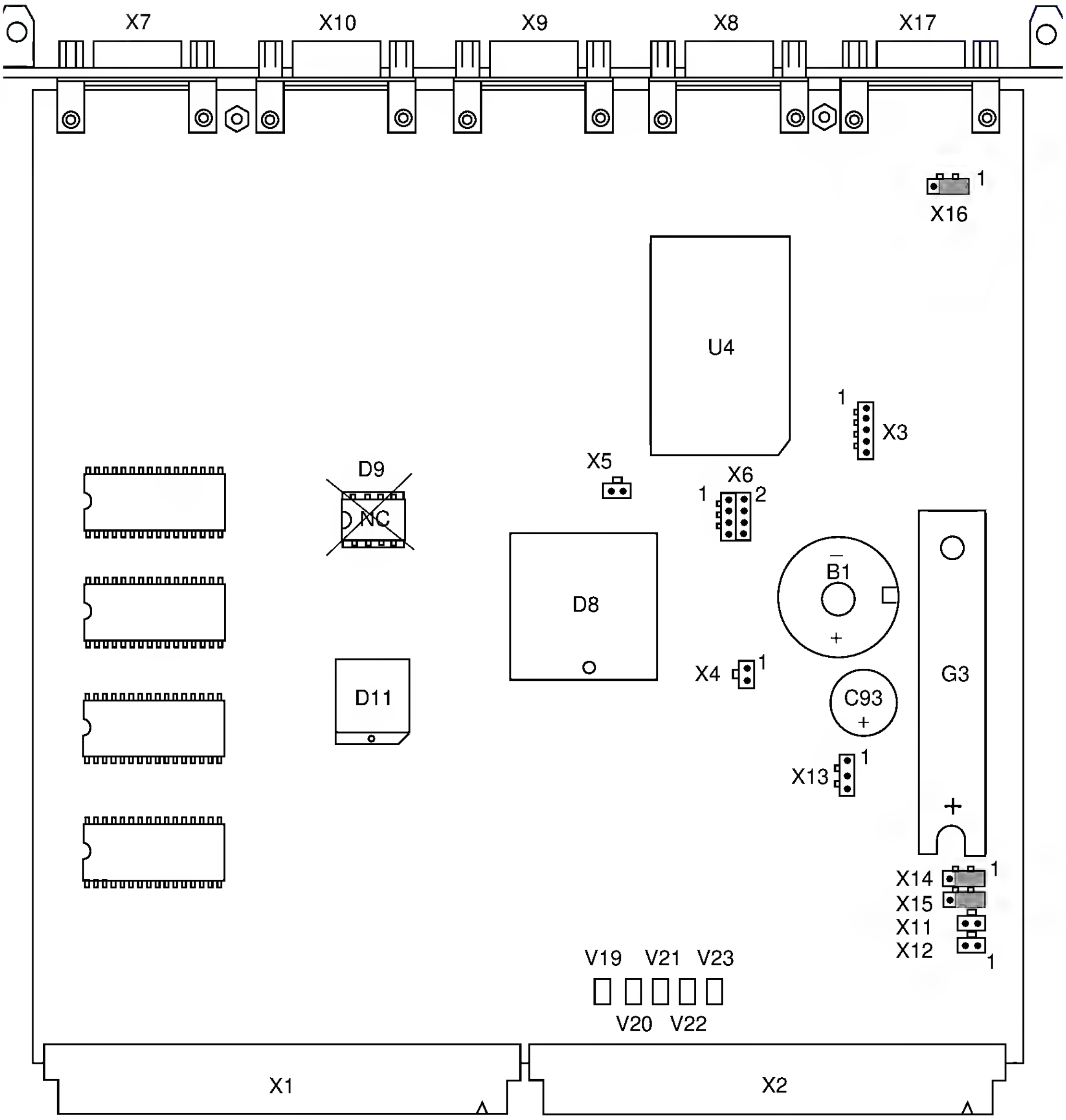
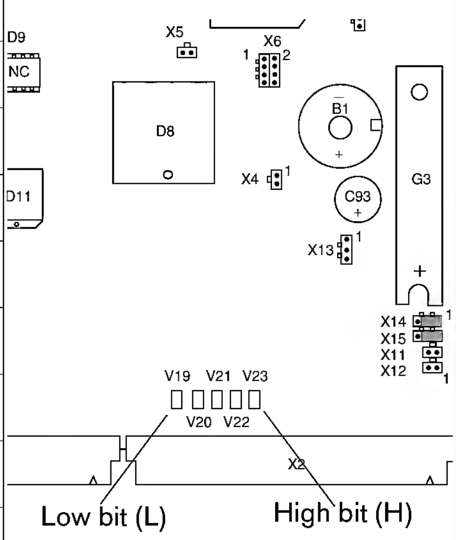


Fig. 36: CIO PCB component layout diagram

B1	Signal generator	D9	(not fitted)
G3	Battery holder	D11	Decoder
U4	DC/DC converter	V19 to V23	LEDs
D8	Microcontroller	C93	Goldcap capacitor

27.4 Service LEDs on CIO PCB

The CIO PCB has 5 service LEDs. These LEDs indicate the following:

LED Display H L	Test	LED Layout
11111	Reset	
00001	RAM error	
00010	CPU error	
00011	Watchdog error	
00000	Normal operation	

In normal operating mode, all LEDs go off, except V23.

In case of malfunction, the above listed combinations may be displayed. If a constant reset is triggered (sound generator is triggered periodically for a short time), the fault may be in the +5 V supply voltage (check supply voltages, see chapter 26.1).

There could also be a fault in the processor system (e.g. defective flash PROM). If this is the case, replace the CIO PCB.

27.5 Replacing Battery on CIO PCB

- Note customer-specific settings (see "Reading out customer configuration" in the annex of the Test Certificate).
- Switch off Julian.
- Remove CIO PCB.
- Remove battery.

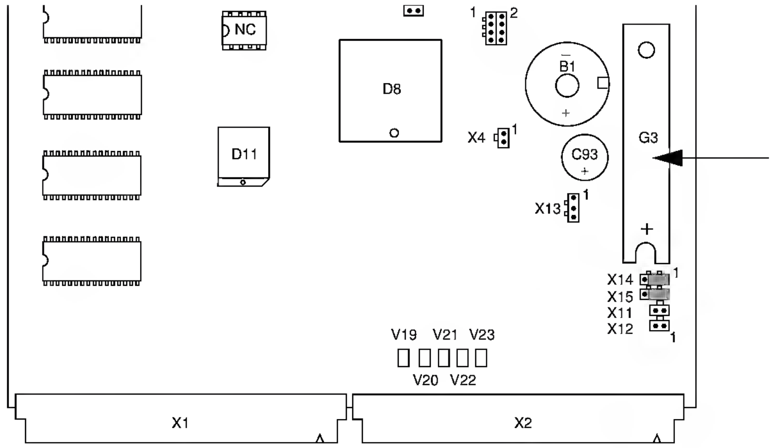


Fig. 37: CPU PCB component layout (battery replacement)

- Fit new battery in battery holder.
- Install CIO PCB.
- Calibrate pressure sensor.
- Set clock.
- Restore customer-specific settings.
- Check Julian according to Test Certificate.

27.6 Replacing CIO PCB

- Note customer-specific settings (see "Reading out customer configuration" in the annex of the Test Certificate).
- Switch off Julian.
- Remove CIO PCB.
- Remove battery from old CIO PCB.

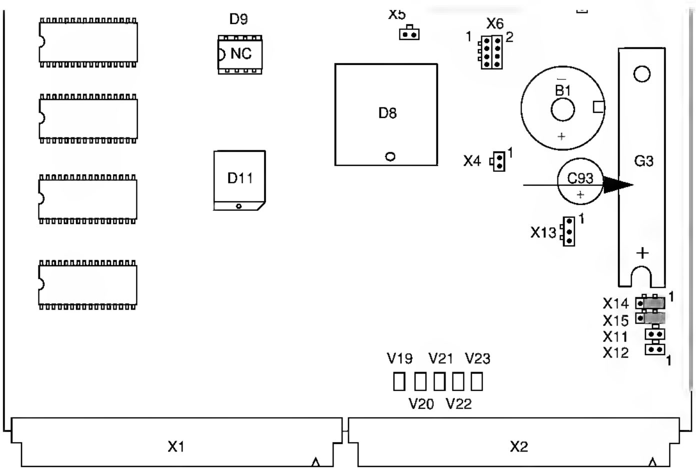


Fig. 38: CIO PCB component layout (PCB replacement)

- Install battery in new CIO PCB.
- Insert new CIO PCB in Julian.
- Check supervisor/master/monitor software version (see "SpO2/Julian Ventilator EDOS" in "Service Mode"). If software version is different, carry out download.
- Calibrate pressure sensor.
- Set clock.
- Restore customer-specific settings.
- Check Julian according to Test Certificate.

27.7 CIOP CB Repair Information

– CIO PCB (8601051)

Caution:

Software problems after replacement of board.

When replacing a board, be aware of the fact that the delivered boards normally come with the current software (flash PROMs).

In order to avoid impermissible software combinations, you should always have the device software on disk or installed on your laptop computer.

27.7.1 Julian starts with default configuration and error message "Battery internal memory flat"

Device-specific and customer-specific information is stored in the battery-buffered RAM of the CIO PCB. This information will be lost if the battery is flat. Julian will then display the message "Default Config. Used" before reaching the check list (as of SW 2.02 in English) and the message "Battery internal memory flat" is displayed in test step 255. Besides flat batteries, dry soldering joints on the battery holder (on the CIO PCB) may be a frequent cause of faults. Soldering joints can be damaged when installing a new battery.

28 Measured Value PCB

Electrostatic discharge may damage electrostatic sensitive devices. **Always use a static-dissipative mat and a wrist strap** when handling electrostatic sensitive devices.

28.1 Overview

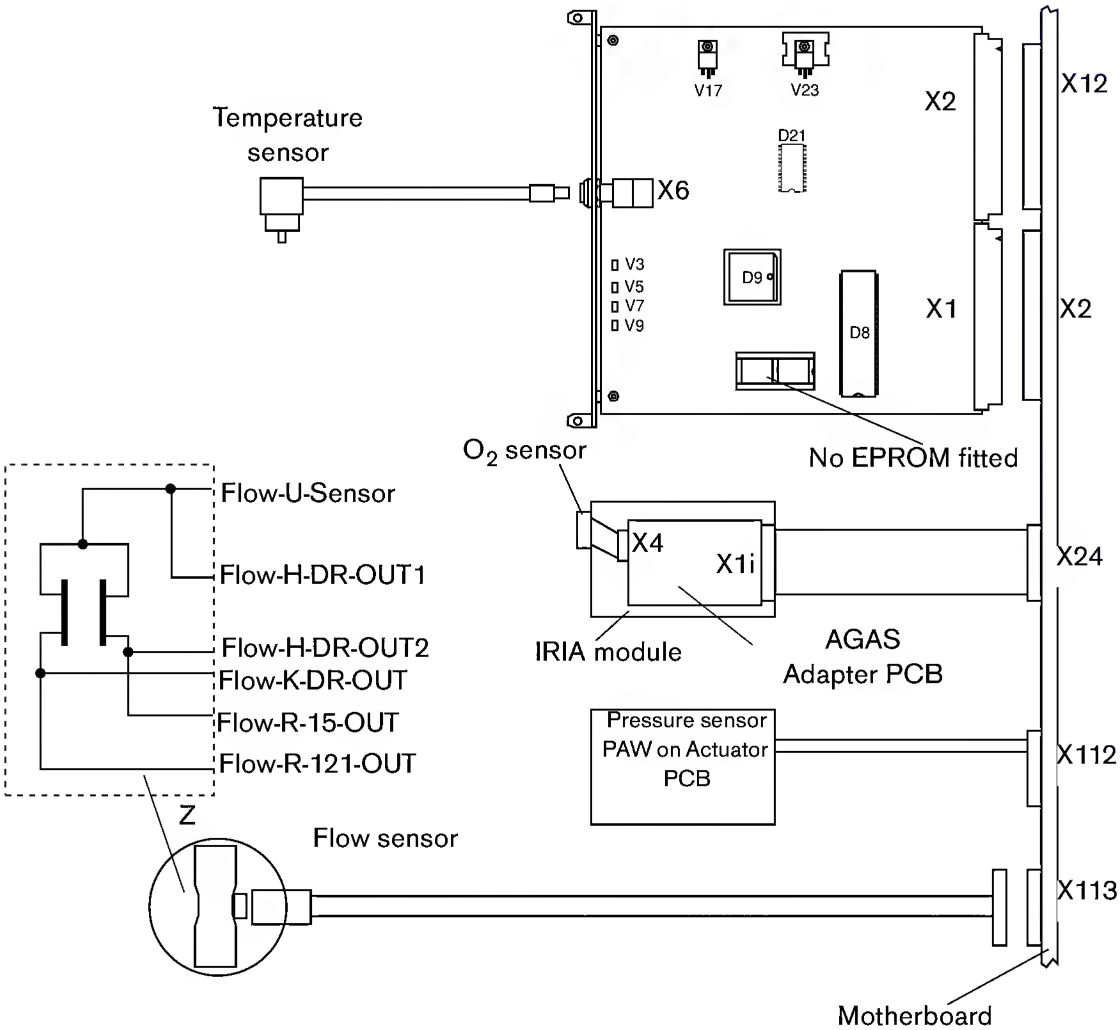


Fig. 39: Layout of connectors

28.2 Measured Value PCB Power Supply

X12 (motherboard)	
Pin	Assignment
1 a/c	AGND
2 a/c	+15 V
3 a/c	– 15 V
4 a/c	GND 12 V
5 a/c	+12 V

X2 (motherboard)	
Pin	Assignment
1+2 a/c	DGND
31+32 a/c	+5 V

28.3 Measured Value PCB Connector Pin Assignment

28.3.1 Flow Measurement

X113	X12	Signal
Pin	Pin	Assignment
7	14a	Flow-H-DR-OUT1
6	13a	Flow-U-Sensor
5	15a	Flow-H-DR-OUT2
4	15c	Flow-R-15-OUT
3	16a	Flow-K-DR-OUT
2	16c	Flow-R-121-OUT

28.3.2 Pressure Measurement

X112	X12	Signal
Pin	Pin	Assignment
13/14	14c	Pressure GND
15	12c	5 V analog
16	13c	Pressure IN PAW (–20 to 100 mbar, corresponding to 0.11 to 2.45 V) 0 mbar corresponding to approx. 0.39 V

28.3.3 O_2 Measurement

X4	X1i	X24	X12	Signal
Pin	Pin	Pin	Pin	Assignment
4	1c	1c	9c	O_2 IN3 (21% corresponding to 11-21 mV)
1	2c	2c	10c	O_2 GND

28.3.4 Temperature Measurement

X6	Signal
Pin	Assignment
1	Temp-GND
2	Temp-SEN (resistance between pins 1 and 2 at 22 °C = approx. 49 kΩ)

28.4 Measured Value PCB Component Layout Diagram

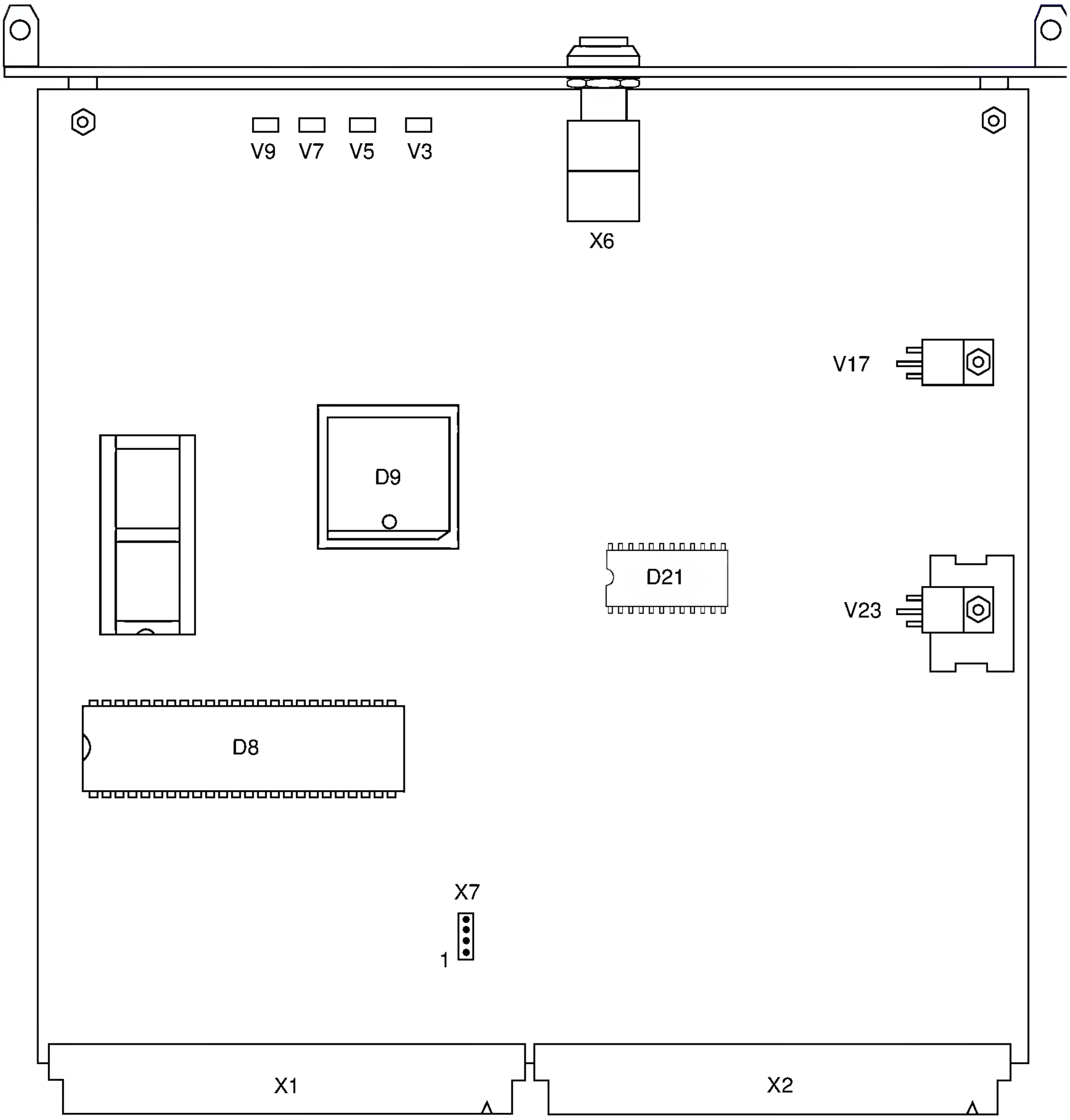
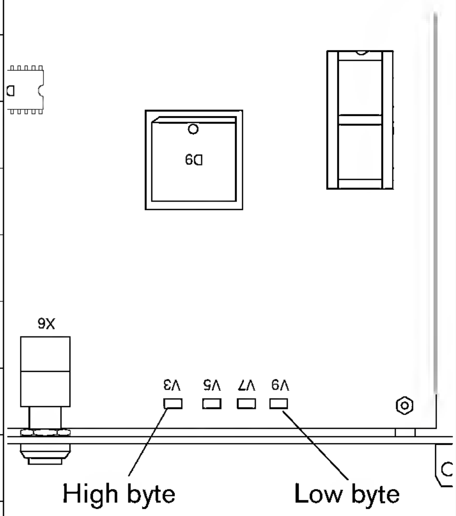


Fig. 40: Measured Value PCB component layout diagram

D8	Dual port RAM
D9	Z80 CPU
V3 to V9	LEDs
V17	BUZ 20
D21	Multiplexer
V23	Voltage regulator 5 V

28.5 Service LEDs on Measured Value PCB

LED Display	Faulty test	LED Layout
0000	No supply voltage	
0001	-	
0010	Z80-PIO	
0011	±5 V	
0100	Sample & Hold	
0101	Flow D/A converter	
0110	Z80 watchdog	
0111	Vref	
1000	-	
1001	-	View of component side of Measured Value PCB Tests are performed in boot phase. All LEDs light briefly at start of boot phase. If not, there is no supply voltage. The other tests are then performed and the corresponding LEDs come on in the event of an error. All LEDs are off on successful completion of testing.
1010	Z80-CTC	
1011	±15 V	
1100	DPR-Z80	
1101	Flow controller	
1110	-	
1111	Boot start	

28.6 Replacing Measured Value PCB

- Switch off Julian.
- Remove Measured Value PCB.
- Insert new Measured Value PCB in Julian.
- Secure Measured Value PCB with screws.
- Assemble Julian ready for operation.
- Check Julian according to Test Certificate.

28.7 Measured Value PCB Repair Information

In the error codes (error descriptions) the Measured Value PCB is sometimes referred to as AIR PCB.

28.7.1 Flow Measurement

An increase in the resistance of the flow sensor socket may result in incorrect flow measurement (resistance cannot always be measured with a multimeter). If this happens, replace connecting cable.

29 Front PCB

Electrostatic discharge may damage electrostatic sensitive devices.
Always use a static-dissipative mat and a wrist strap when handling electrostatic sensitive devices.

29.1 Front PCB Power Supply

X9 (X5 motherboard)	
Pin	Assignment
1 to 2 a/c	DGND
31 to 32 a/c	+5 V

X10 (X15 motherboard)	
Pin	Assignment
1 a/c	AGND
2 a/c	+15 V
3 a/c	–15 V

29.2 Front PCB Connector Pin Assignment

29.2.1 LEDs

X10 (X15 motherboard)	
Pin	Assignment
9 a	LED0
10 a	LED1
11 a	LED2
12 a	LED3
13 a	LED4
14 a	LED5

X10 (X15 motherboard)	
Pin	Assignment
15 a	LED6
16 a	LED7
4 a	LED8
5 a	LED9
6 a	LED10
7 a	LED11

29.2.2 Keys

X10 (X15 motherboard)	
Pin	Assignment
9 c	Key 0 (Quit)
10 c	Key1
11 c	Key2
12 c	Key3
13 c	Key4
14 c	Key5
15 c	Key6
16 c	Key7
17 a	Key8
17 c	Key9
18 a	Key10
18 c	Key11

X10 (X15 motherboard)	
Pin	Assignment
19 a	Key12
19 c	Key13
20 a	Key14
6 b	Key15
7 b	Key16
8 b	Key17
9 b	Key18
10 b	Key19
11 b	Key20
12 b	Key21
13 b	Key22
14 b	Key23

29.2.3 Rotary Knob

X10 (X15 motherboard)	
Pin	Assignment
21 a	DIGIPOTIA
21 c	DIGIPOTIB

29.2.4 Loudspeaker

X10 (X15 motherboard)	
Pin	Assignment
23 a	LOUDSP1 (AGND)
23 c	LOUDSP2

29.2.5 CAN Interface

X10 (X15 motherboard)	
Pin	Assignment
32 a	CANH
30 a	CANL
31 a	GNDCAN

X8	
Pin	Assignment
1	CANH
2	CANL (via resistor to pin 30 a)

29.2.6 Debug Interface

X20	
Pin	Assignment
1	+5 V-REST5 (5 V behind restrictor)
2	NC
3	CRXD
4	CTXD
5	DGND

29.3 Front PCB Component Layout Diagram

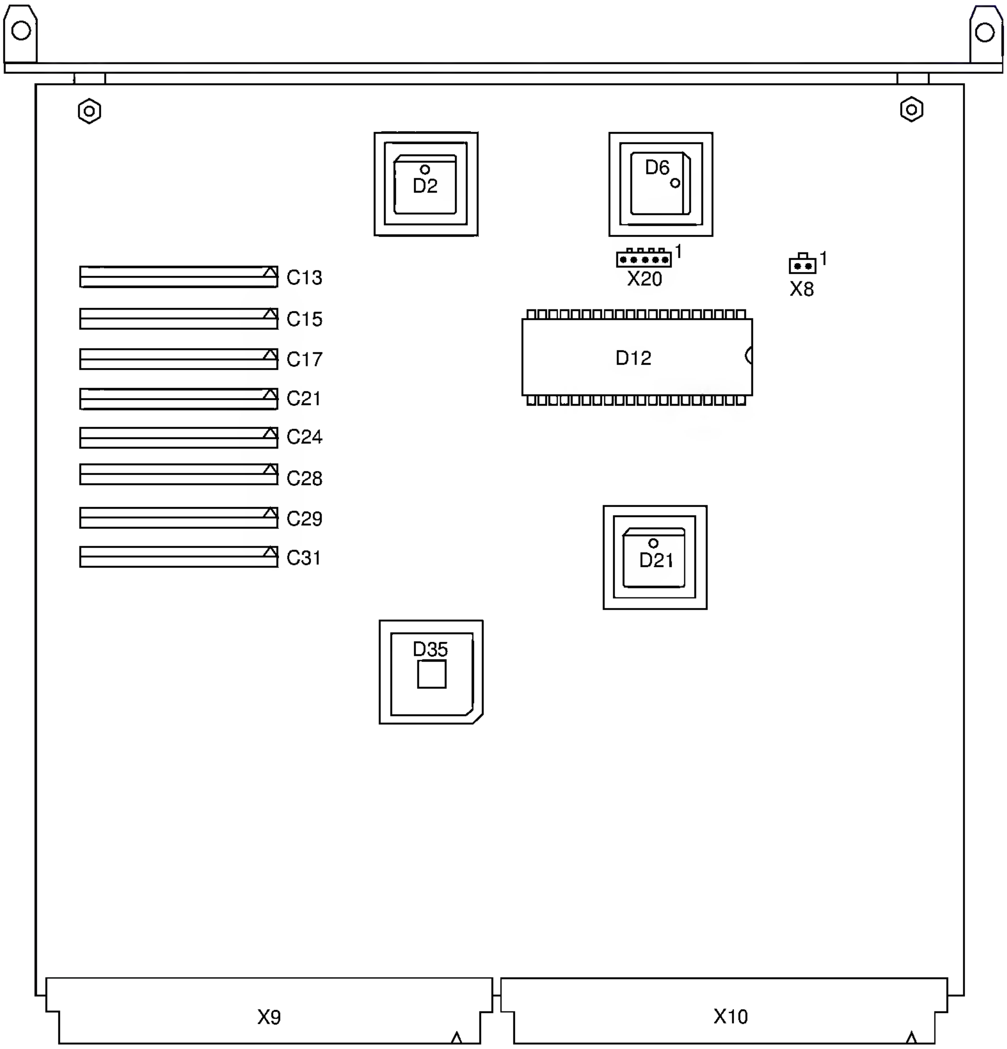


Fig. 41: Front PCB component layout diagram

29.4 Replacing Front PCB

- Switch off Julian.
- Remove Front PCB.
- Insert new Front PCB in Julian.
- Mount new Front PCB.
- Check Julian according to Test Certificate.

29.5 Front PCB Repair Information

29.5.1 Error Log with Error Code 12005

Error Description

Error code 12005 is mainly entered in the error log of Julian. This makes storing of other error messages impossible for a prolonged duration.

Error Cause

One of the CAN components used on Front 4 PCB (order no. 8600981) is the P87C592 EFA from Philipps. Software was developed and tested for this component. Philipps reworked the CAN component and changed the pin configuration on one of the pins. These changes were not implemented into the current software.

Repair Procedure

Service equipment required

Quantity	Description	Item Number
2	SMD resistor 1 kΩ	1816276
	or:	
2	Wired resistor 1 kΩ	1806653

Procedure

- Switch off Julian.
- Unscrew rear panel of electronics module.

Electrostatic discharge may damage electrostatic sensitive devices. **Always use a static-dissipative mat and a wrist strap** when handling electrostatic sensitive devices.

- Remove Front 4 PCB (second slot from the left) from Julian.
- Place Front 4 PCB on static-dissipative mat with component side facing down.
- Solder both 1 kΩ resistors as shown in the Figure below.

Repairs can be made with SMD resistors as well as wired resistors.

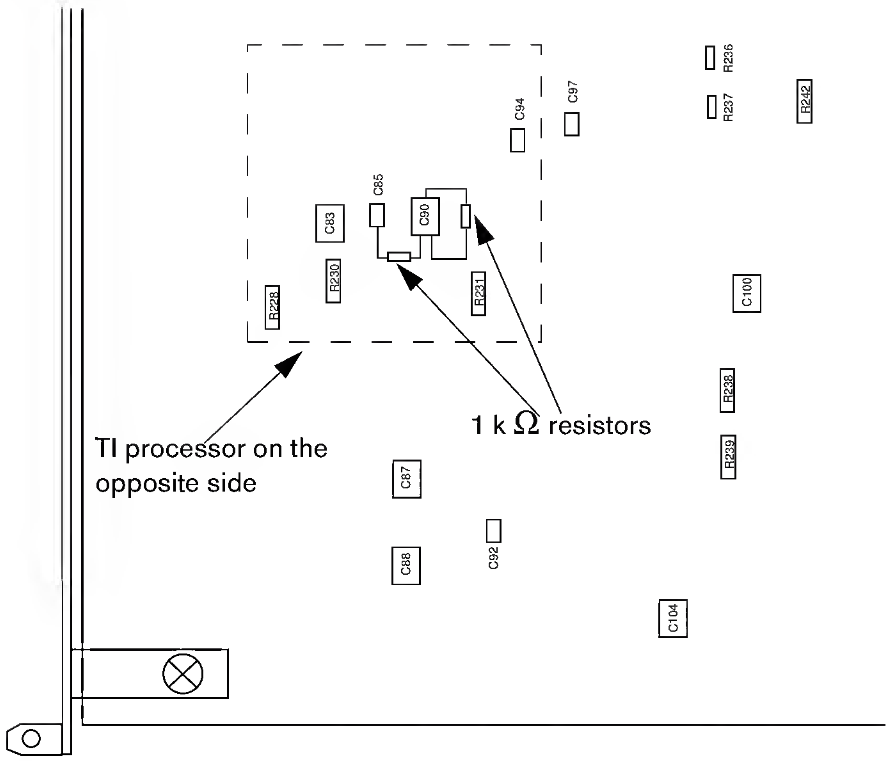


Fig. 42: Rear view of Front 4 PCB

- Mount Front 4 PCB and rear panel of electronic assembly.

Final Tests

- Perform safety test according to Julian Test Certificate, test item "22.".
- Connect Julian to pipeline system and AC outlet
- Switch on Julian and confirm initialization of self test.
- As soon as Julian is in standby, switch to IPPV mode.
- Allow Julian to operate for 5 minutes.
- Disconnect sampling hose from Y-piece and breath into connector of the sampling hose.

After several seconds the CO_2 display should show an increased CO_2 value.

- Reconnect the sampling hose.

The CO_2 display should return to 0%.

29.5.2 "Afterglowing" of Julian Display

Undesired afterglowing of pixels may occur on the Julian display. This effect can be corrected by mounting an additional resistance plug (part no. 8601857) on the Front PCB.

Proceed as follows:

Electrostatic discharge may damage electrostatic sensitive devices. **Always use** a static-dissipative mat and a wrist strap **when handling electrostatic sensitive devices.**

- Remove the rear panel.
- Remove the fixing screws of the IRIA module.
- Disconnect the two hoses (anesthetic gas sampling hose and sampling gas scavenging/return hose) from the IRIA module.
- Remove the IRIA module.
- Remove the two electrical ribbon cable which interconnect the Front PCB and the motherboard.
- Remove the protective conductor from the motherboard.
- Remove the fixing screws from the electronics plug-in unit and pull out the plug-in unit about 10 to 15 cm.
- Plug the resistance plug onto J3 (see the following Figure).

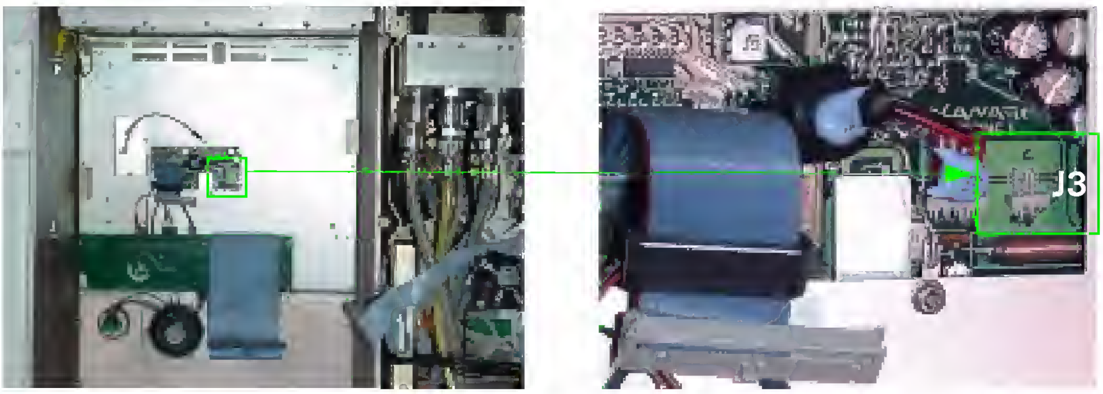
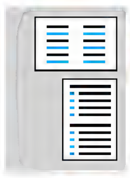


Fig. 43: Position of J3 on the Front PCB

- Assemble components using the reverse order.



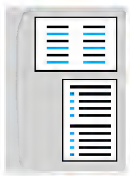
- Carry out a functional test of the display, keys, and control knob while the unit is switched on. To do so, switch the unit to an operating mode (for example, IPPV), push each individual key, and observe the respective reaction on the display. Check also the function of the control knob.
- Carry out a safety check according to Test Certificate.

30 Front Adapter PCB

Electrostatic discharge may damage electrostatic sensitive devices. **Always use a static-dissipative mat and a wrist strap** when handling electrostatic sensitive devices.

30.1 Front Adapter PCB Power Supply

X1	
Pin	Assignment
47/48	DGND
49/50	+5 V
51/53/55/57/59	12VGND
52/54/56/58/60	+12 V



30.2 Front Adapter PCB Connector Pin Assignment

30.2.1 LEDs

X1 (to motherboard)	X12 (to LED)	
Pin	Pin	Assignment
25	1	NTP – (charge indicator LED of power supply unit batteries)
26	2	NTP +

X1 (to motherboard)	X6 (to LEDs)	
Pin	Pin	Assignment
27	49	LED0
28	47	LED1
29	45	LED2
30	43	LED3
31	41	LED4
32	39	LED5
33	37	LED6
34	35	LED7
35	33	LED8
36	31	LED9
37	29	LED10
38	17	LED11

30.2.2 Keys

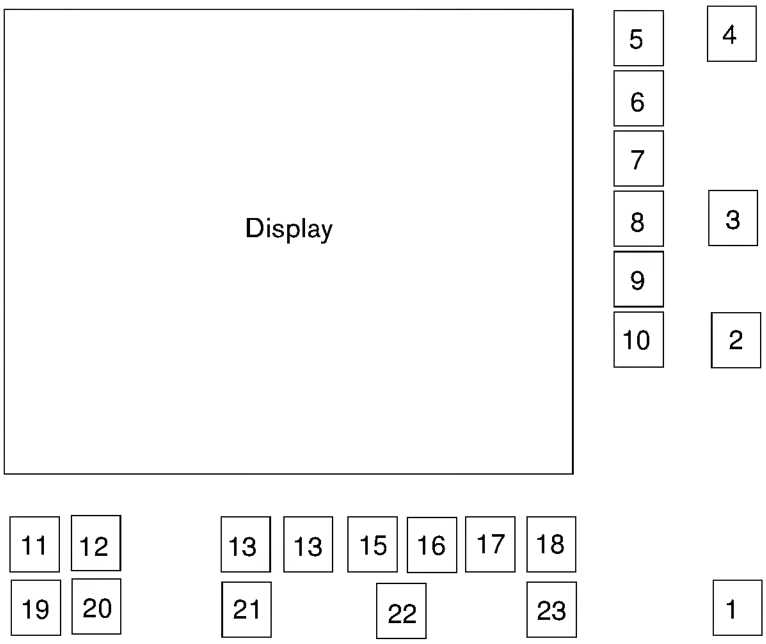


Fig. 44: Key positions on the display

X1 (to motherboard)	X6 (to keys)	
Pin	Pin	Assignment
2	48	Key1
3	46	Key2
4	44	Key3
5	42	Key4
6	40	Key5
7	38	Key6
8	36	Key7
9	34	Key8
10	32	Key9
11	30	Key10
12	28	Key11
13	26	Key12
14	24	Key13
15	22	Key14

X1 (to motherboard)	X6 (to keys)	
Pin (Forts.)	Pin (Forts.)	Assignment
16	20	Key15
17	18	Key16
18	16	Key17
19	14	Key18
20	12	Key19
21	10	Key20
22	8	Key21
23	6	Key22
24	4	Key23

30.2.3 Rotary Knob

X1 (to motherboard)	X9 (to rotary knob)	
Pin	Pin	Assignment
1	3	Key0
39	5	DIGIPOTIA
40	4	DIGIPOTIB
47/48	1/2	DGND
49/50	6	+5 V

30.2.4 Loudspeaker

X1 (motherboard)	X10 (to loudspeaker)	
Pin	Pin	Assignment
41	2	LOUDSP1 (AGND)
42	3	LOUDSP2

30.2.5 Power Switch

X1 (from motherboard)	X8 (to power switch)	
Pin	Pin	Assignment
43	1	Mains0
44	2	Mains1
45	3	Mains2
46	4	Mains3

30.2.6 Display Power Supply

X4 (to display)	
Pin	Assignment
1/4	+12 V (from closing current limiter on Front Adapter PCB)
2/3	12 VGND

30.3 Front Adapter PCB Component Layout Diagram

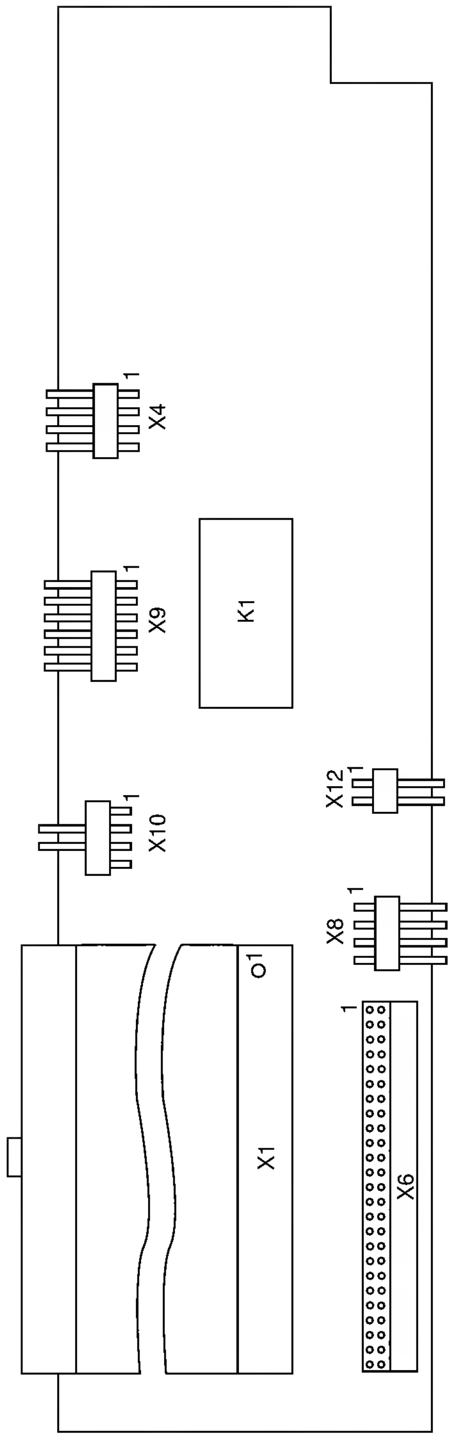


Fig. 45: Front Adapter PCB component layout

30.4 Replacing Front Adapter PCB

- Switch off Julian.
- Remove Front Adapter PCB.
- Insert new Front Adapter PCB in Julian.
- Mount new Front Adapter PCB.
- Check Julian according to Test Certificate.

30.5 Front Adapter PCB Repair Information

- No entries -

31 Power Supply Unit, DC/DC Converter

Contents

32 Power Supply Unit

32.1 Safety Precautions

Carefully read and understand the following safety precautions before servicing the power supply unit.

Hazardous voltage. Risk of personal injury.
Pull power plug out of AC outlet before servicing.

Electrostatic discharge may damage electrostatic sensitive devices.
Always use a static-dissipative mat and a wrist strap when handling electrostatic sensitive devices.

When dismounting the power supply unit or the DC converter make sure to disconnect the data cable first. Only then may you disconnect the 24 V supply cable between the power supply unit and the DC converter.
When mounting the devices, always connect the 24 V supply cable first and make sure that all cables are secured properly. Only then may you mounte the data cable. A wrong sequence may irreversibly damage the DC converter.

Hazardous voltage.
A short circuit fault in the two power cables (power supply unit to DC/DC converter) will result in sparking and irreversibly damage power supply unit and rechargeable batteries. Voltage is still present even with power plug pulled out of AC outlet. **Always disconnect power cable from power supply unit first.**

Applies to power supply unit 8601619 with internal batteries:

If the **automatic circuit breaker** is set to **OFF**, Julian will not be supplied with power in the event of a power failure. **Always switch the automatic circuit breaker to ON**.

32.2 Power Supply Unit Components

Since 1998 Julian comes with a new type of power supply unit. The new type of power supply unit differs from the old type by the following:

– The power cable is connected to the power supply unit through a plug for non-heating apparatus.

– As of version "Ver03": The automatic circuit breaker/battery switch is mounted on the front panel.

– As of version "Ver04": Since March 1999, the plus line to the external batteries is provided with a 25 A fuse. The battery switch is no longer used.

– As of version "Ver05": The power supply unit automatically monitors the status of the batteries. As of software version 2.02 of Julian, this battery monitoring function is evaluated by the software. To ensure this, the battery detection in Service Mode/Service2/Further must be set to "ON". For power supply units Ver < 05, the battery detection must be set to "OFF". Otherwise error messages may occur during the self-test.

– The external fan is powered with +12 V. The type of external fan is identical with the fan used in the DC converter. However, the connectors are different.

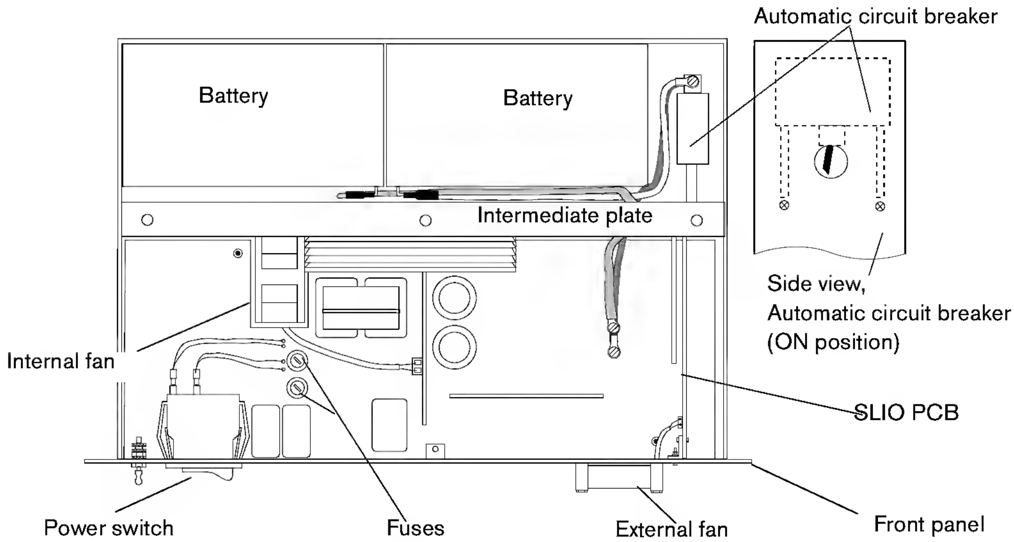


Fig. 46: Power supply unit 8601619 components, "Ver01" and "Ver02"

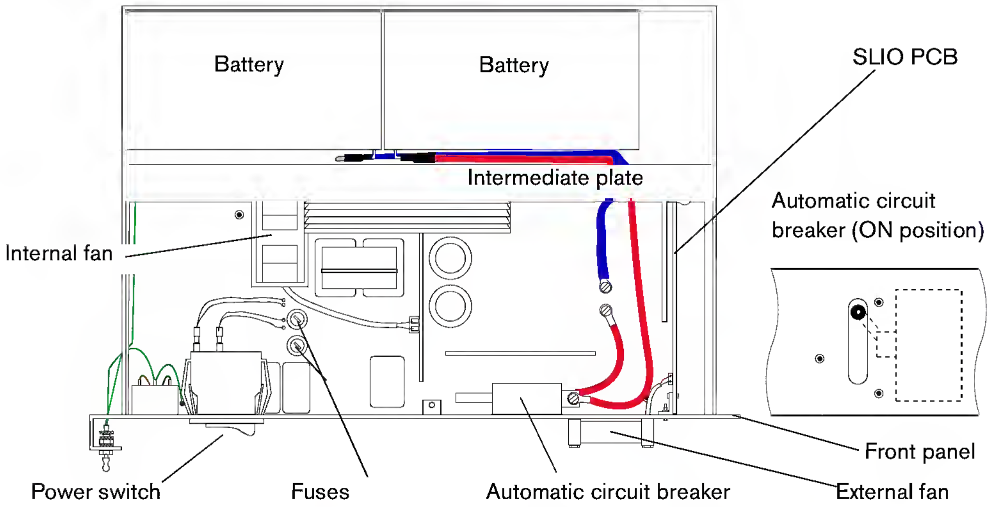


Fig. 47: Power supply unit 8601619 components, version "Ver03"

Fig. 48: Installed power supply unit 8601765, external battery pack 8601764 as of version "Ver04"

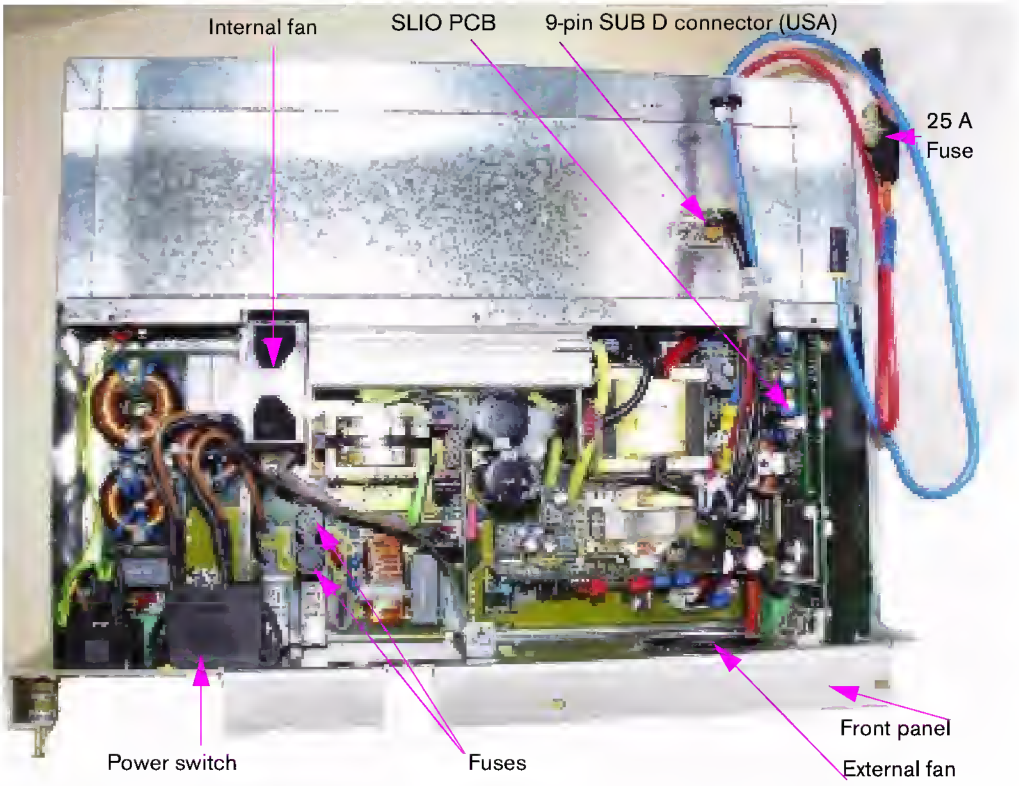
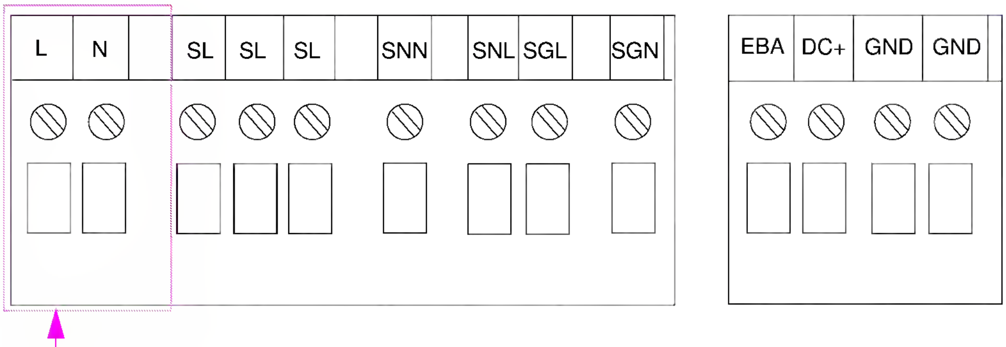


Fig. 49: Components of power supply unit 8601765 as of version "Ver04"

32.3 Power Supply Unit Connector Pin Assignment

Connectors "L" and "N" are not used in power supply units with plug for non-heating apparatus.



Not available in power supply units 8601619 with plug for non-heating devices as of version "Ver03"

Fig. 50: Power supply unit connector pin assignment

AC voltage	
Pin	Assignment
L	Phase
N	Neutral conductor
SL	Protective earth conductor
SNN	Neutral conductor output, non-switched
SNL	Phase output, non-switched
SGL	Phase output, switched
SGN	Neutral conductor output, switched

DC voltage	
Pin	Assignment
EBA	External battery
DC+	Output
at AC operation	29 V to 30.5 V
at battery operation	18.5 V to 29 V
GND	Ground

9-pin SUB D connector (USA)	
Pin	Assignment
1	GND
2	GND

9-pin SUB D connector (USA)	
Pin	Assignment
4,6,7,8,9	NC
5	LED output 8 (+-2) mA at 2 V

AC voltage	
Pin	Assignment
3	18,5 V to 30.5 V DC

DC voltage	
Pin	Assignment

32.4 Replacing Power Supply Unit

- Pull power plug out of AC outlet.

Caution:

Risk of damage to the DC converter if an incorrect sequence is used when dismounting/mounting the power supply unit or the DC converter.

When dismounting the power supply unit or the DC converter always make sure to disconnect the data cable first. Only then may you disconnect the 24 V supply cable between the power supply unit and the DC converter.

When mounting the devices, always connect the 24 V supply cable first and make sure that all cables are secured properly. Only then may you mount the data cable.

Caution:

Hazardous voltage.

A short circuit fault in the two power cables (power supply unit to DC/DC converter) will result in sparking and cause irreversible damage to power supply unit and rechargeable batteries. Voltage is still present even with power plug pulled out of AC outlet.

Always disconnect power cable from power supply unit first.

- Always remove the data cable **A** between the power supply unit and the DC/DC converter first.
- Disconnect connecting cable **B** from power supply unit.
- Remove the ground connection **C** between the power supply unit and the DC/DC converter.

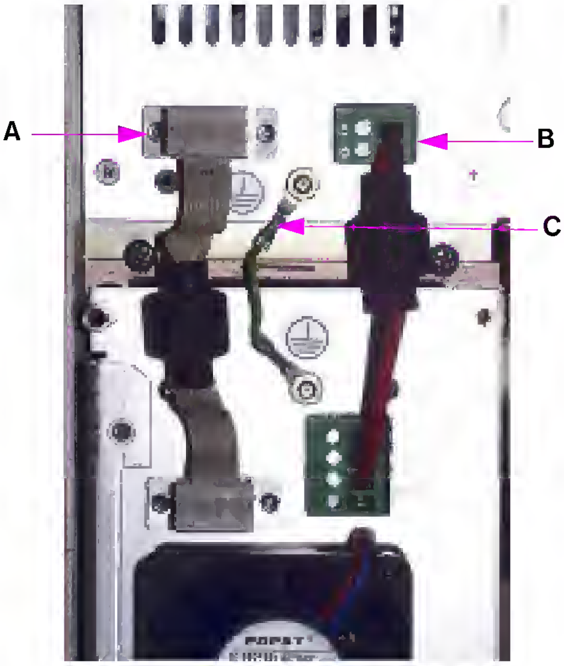


Fig. 51: Disconnecting cables

- Applies to power supply unit 8601765:
  Disconnect supply conductors from external batteries 8601764.

- Note position of power leads **CA**.
- Remove the power cables **CA**.
- Remove fastening screws **D** from power supply unit.

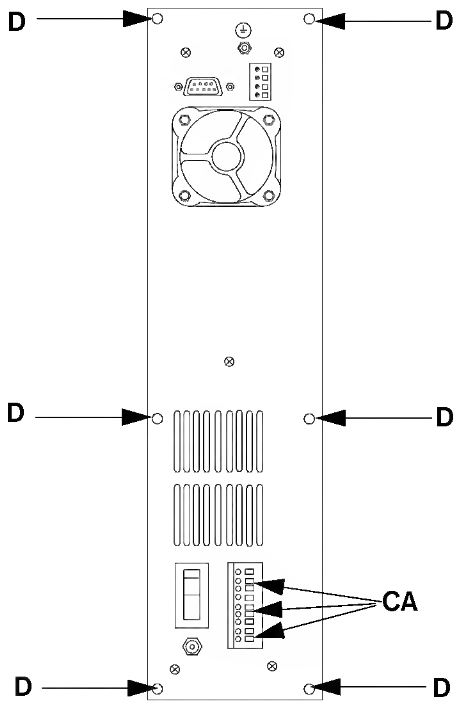


Fig. 52: Disconnecting power cables

- Remove power supply unit. Follow the safety precautions described under 32.1 "Safety Precautions".
- Applies to power supply units with permanently installed power cable:
  Dismount the power cable from the old power supply unit.
  The new power supply unit comes with a plug for non-heating devices. Mount this plug to the power cable.

Caution:

During assembly, mount the 24 V power cable first, then the data cable.

- Install new power supply unit using the reverse method of that used for removal.

- When converting the power supply unit 8601619 into a power supply unit with external batteries, follow the respective conversion instructions.

Insufficient voltage. New batteries do not have sufficient charge. **Leave Julian connected to AC outlet for at least 10 hours** (Julian does not need to be switched ON).

- Carry out safety and function tests according to Test Certificate.

32.5 Replacing Rechargeable Batteries

32.5.1 Power Supply Unit 8601619 "Ver01" through "Ver03"

- Switch off Julian.
- Pull power plug out of AC outlet.
- Remove power supply unit. Follow the safety precautions described under 32.1 "Safety Precautions".
- Remove screws **A** from power supply unit cover.

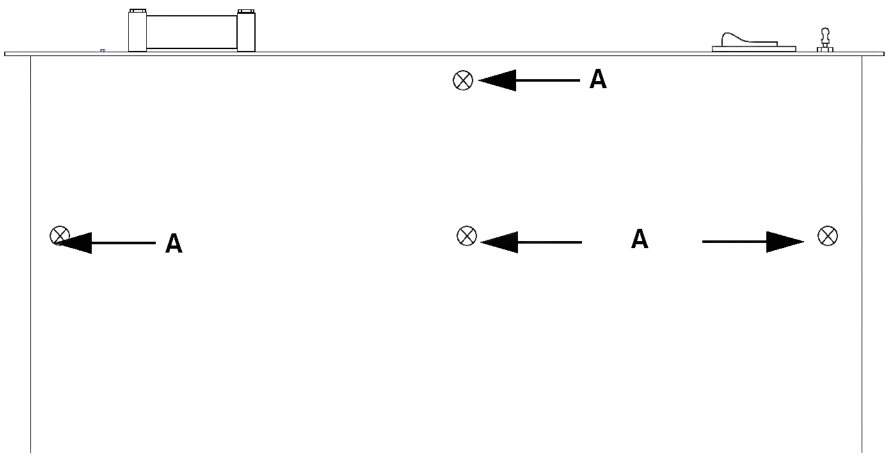


Fig. 53: Power supply unit cover

- Remove power supply unit cover.

- Applies to power supply units versions "Ver01" and "Ver02":
  Set automatic circuit breaker to OFF by pressing down lever **B**.

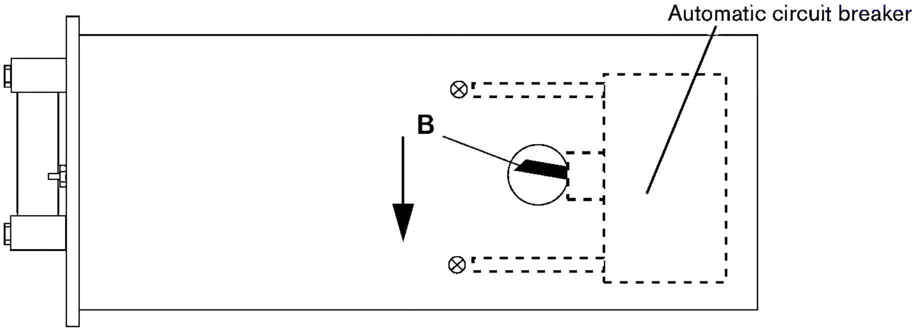


Fig. 54: Side view of power supply unit with automatic circuit breaker

- Applies to power supply unit "Ver03":
  Set automatic circuit breaker to position OFF by pressing down lever **C**.

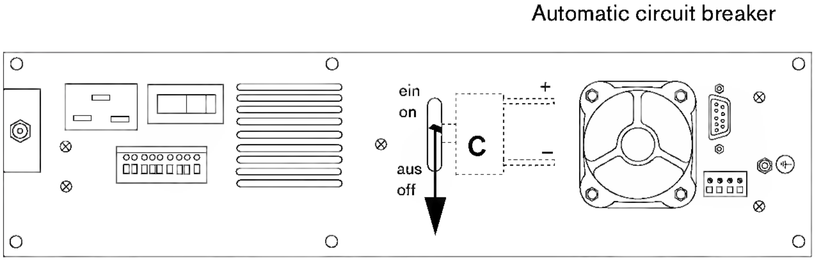


Fig. 55: Side view of power supply unit with automatic circuit breaker

- Disconnect cable from battery negative terminal (blue cable).
- Disconnect cable from battery positive terminal (red cable).

Lead/gel batteries are special waste. Dispose of batteries according to local waste disposal regulations.

- Remove batteries from power supply unit.
- Disconnect cable which connects the two batteries.

Reverse battery polarity will damage both batteries and power supply unit. **When installing new batteries, make sure battery polarity is correct.**

- Install new batteries using the reverse method of that used for removal of old ones.

Insufficient voltage. New batteries do not have sufficient charge. **Leave Julian connected to AC outlet for at least 10 hours** (Julian does not need to be switched ON).

- Carry out safety and function tests according to Test Certificate.

32.5.2 Power Supply Unit 8601765 "Ver04" or higher with External Batteries 8601764

- Switch off Julian.
- Pull power plug out of AC outlet.
- Disconnect both battery supply conductors.
- Remove and dispose of old retaining rubber bands.
- Replace batteries with new ones.

Lead/gel batteries are special waste. Dispose of batteries according to local waste disposal regulations.

- Mount new retaining rubber bands. Dispose of included battery holder.

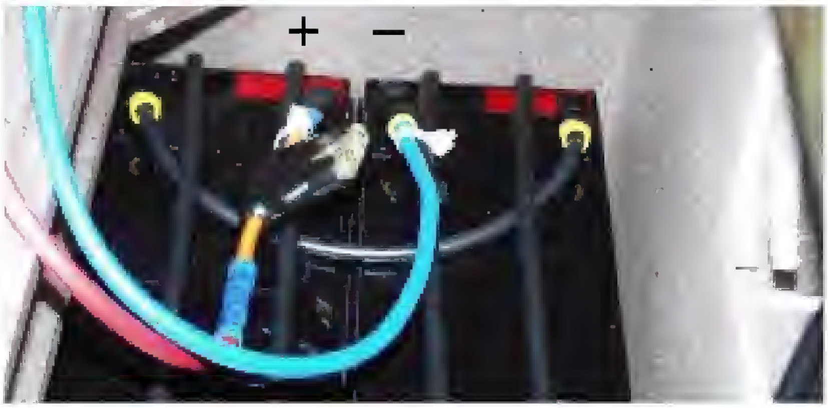


Fig. 56: Connecting and securing battery supply conductors

Reverse battery polarity will damage both batteries and power supply unit.

- When connecting the battery supply conductors, make sure the polarity is correct (Fig. 56: "Connecting and securing battery supply conductors")
  Secure battery supply conductors using cable ties.

Insufficient voltage. The new batteries are not charged sufficiently. **Leave Julian connected to AC outlet for at least 10 hours** (Julian does not need to be switched ON).

- Perform a VDE test and submit uninterruptible power system (UPS) to a function test according to the Test Certificate.

32.6 Replacing External Fan

External fan only runs when Julian is switched ON.

- Switch off Julian.
- Pull power plug out of AC outlet.
- Remove power supply unit. Follow the safety precautions described under 32.1 "Safety Precautions".
- Remove screws **A** from power supply unit cover.

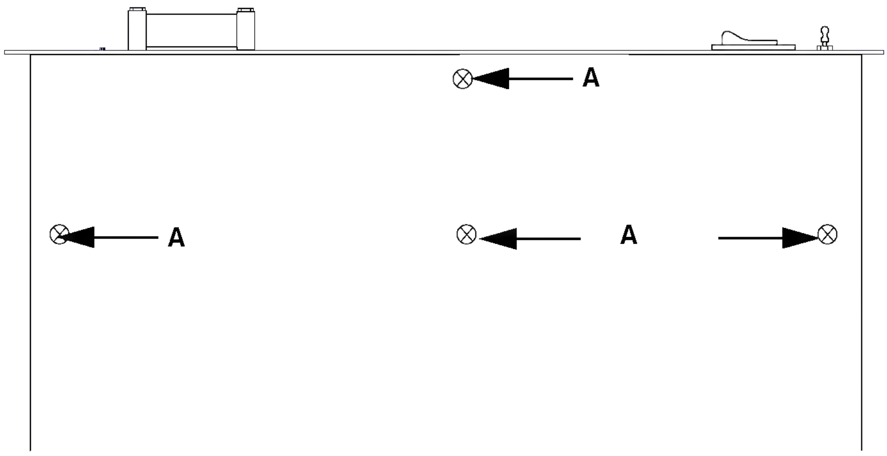


Fig. 57: Power supply unit cover

- Remove power supply unit cover.

- Applies to power supply units 8601619 up to and including "Ver02":
  Set automatic circuit breaker to OFF by pressing down lever **B**.

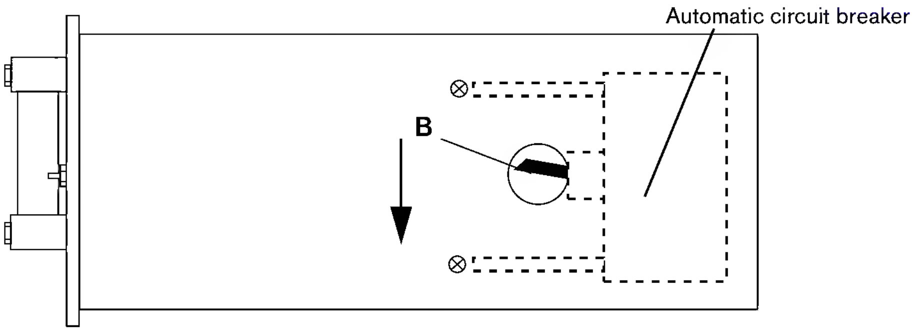


Fig. 58: Side view of power supply unit with automatic circuit breaker

- Applies to power supply units 8601619 "Ver03" or later:
  Set automatic circuit breaker to OFF by pressing down lever **BB**.

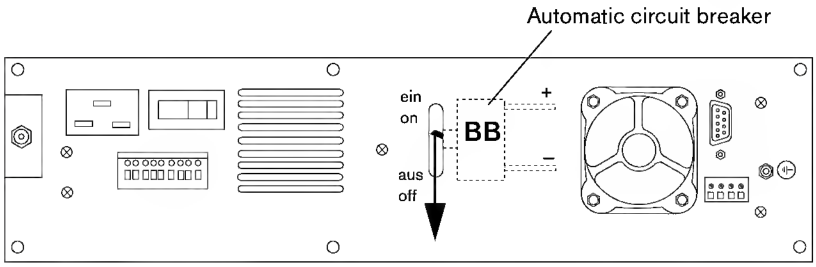


Fig. 59: Side view of power supply unit with automatic circuit breaker

- Applies to power supply unit 8601765:
  Disconnect supply conductors from external batteries.

- Disconnect connector **C** from SLIO PCB.
- Remove both fastening screws **D** of the "data socket".

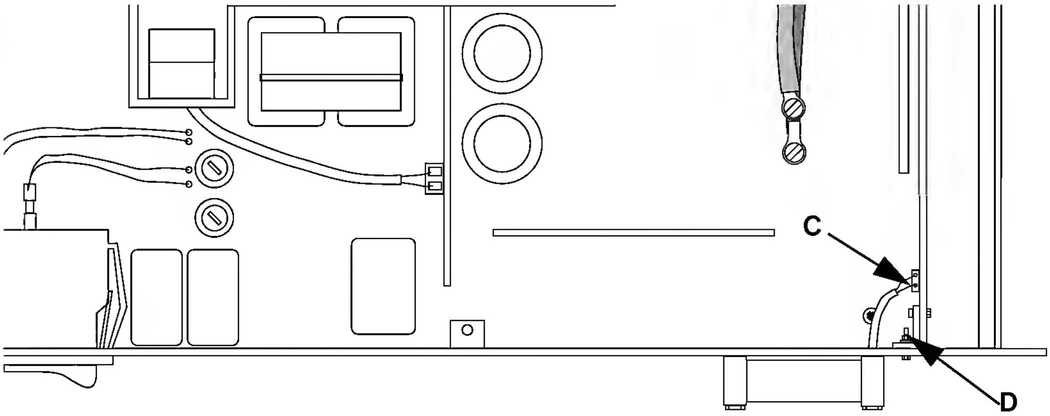


Fig. 60: External fan connection

- Remove five fastening screws **E** from front panel.

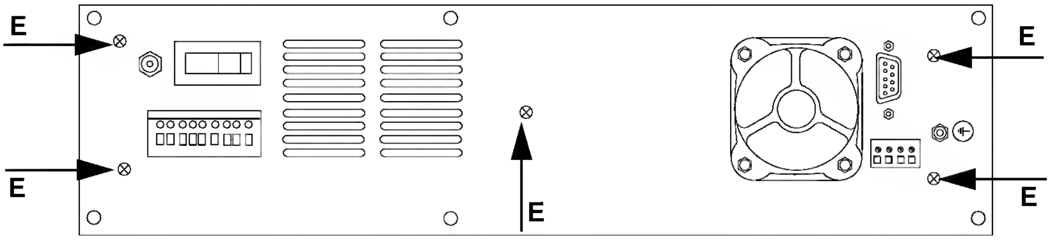


Fig. 61: Detaching front panel

- Fold front panel down.
- Note installation position of fan.
- Remove four fastening screws **F** from fan.

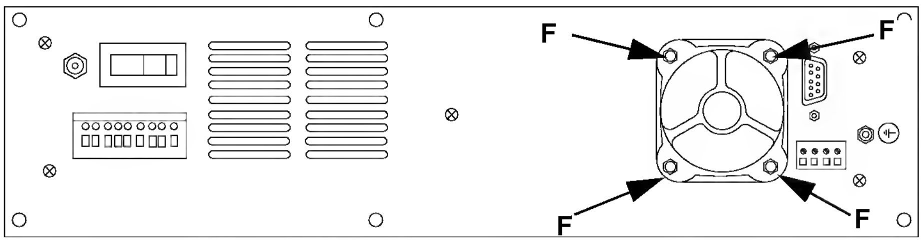


Fig. 62: Removing fan

- Remove fan.
- Mount new fan in reverse order of that used for dismounting.
- Carry out safety and function tests according to Test Certificate.

32.7 Replacing Internal Fan

The internal fan starts running as soon as Julian is connected to the AC outlet and the power switch on the power supply unit is set to ON. The running noise is clearly audible.

- Switch off Julian.
- Pull power plug out of AC outlet.
- Remove power supply unit. Follow the safety precautions described under 32.1 "Safety Precautions".
- Remove screws **A** from power supply unit cover.

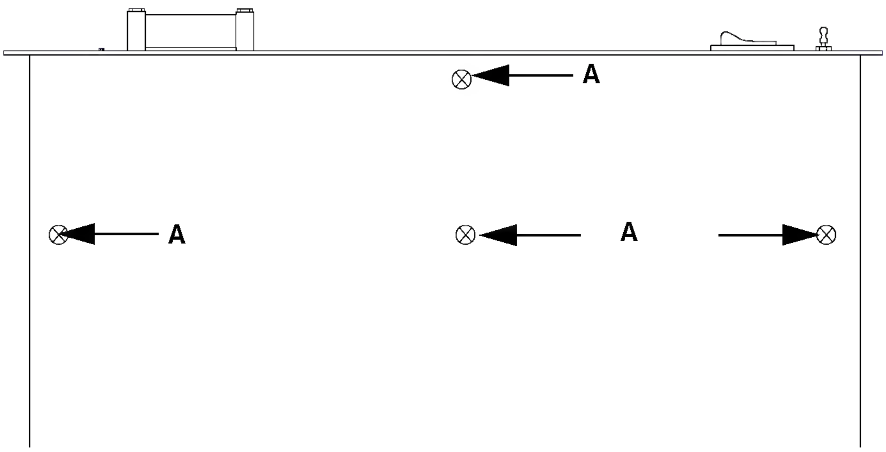


Fig. 63: Power supply unit cover

- Remove power supply unit cover.

- Applies to power supply units 8601619 up to and including "Ver02":
  Set automatic circuit breaker to OFF by pressing down lever **B**.

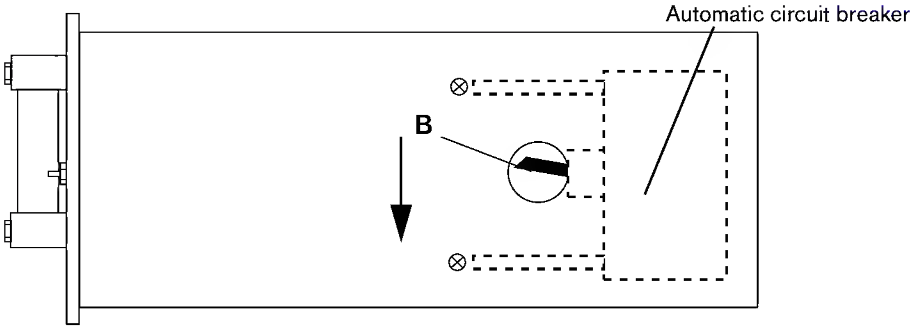


Fig. 64: Side view of power supply unit with automatic circuit breaker

- Applies to power supply units 8601619 "Ver03" or later:
  Set automatic circuit breaker to position OFF by pressing down lever **C**.

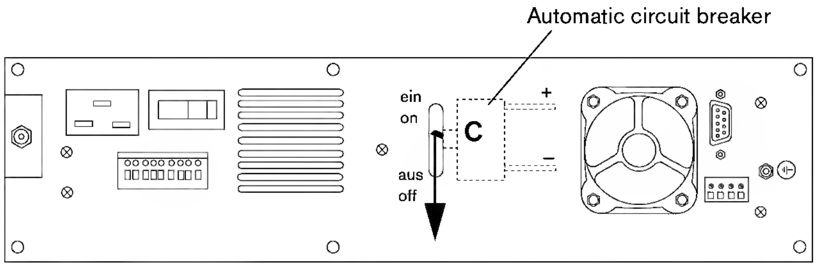


Fig. 65: Side view of power supply unit with automatic circuit breaker

- Applies to power supply unit 8601765:
  Disconnect supply conductors from external batteries.
- Disconnect cable from battery negative terminal (blue cable).
- Disconnect cable from battery positive terminal (red cable).

- Remove three fastening screws **E** from underside of power supply unit.

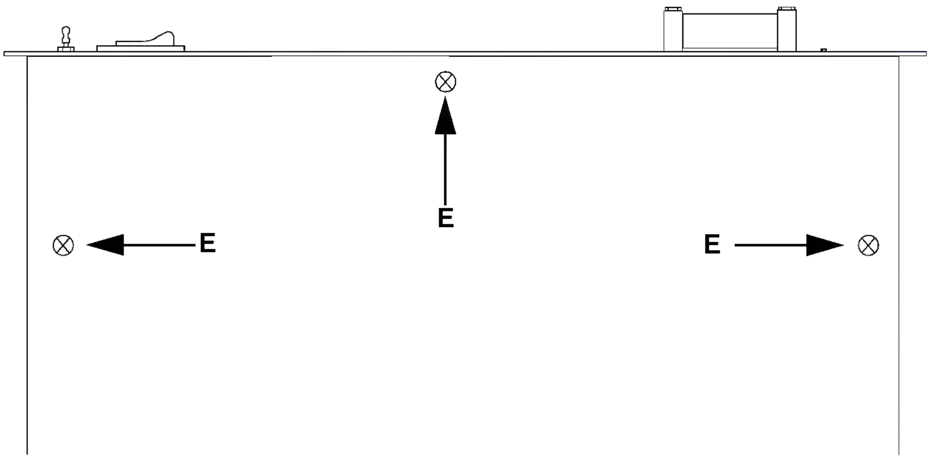


Fig. 66: Bottom view of power supply unit

- Remove four fastening screws **C** from front panel.

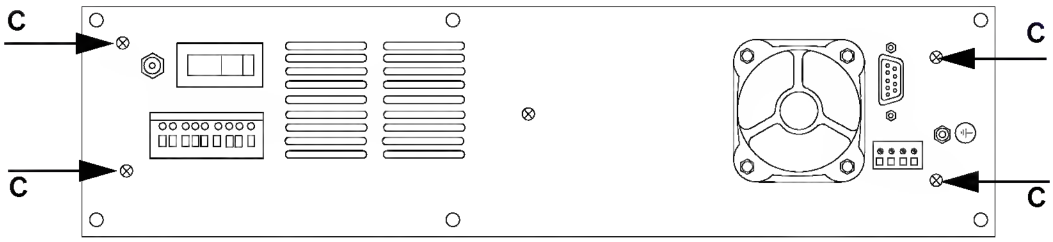


Fig. 67: Detaching front panel

- Remove four fastening screws **D** from intermediate plate.

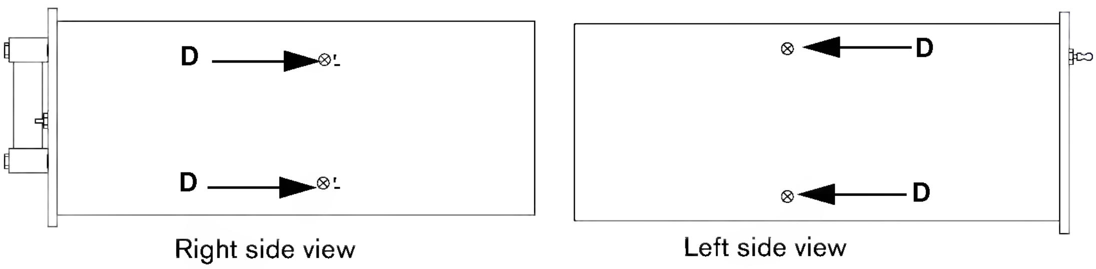


Fig. 68: Removing the intermediate plate

- Remove electronics module from power supply unit housing.
- Remove two fastening screws **F** from underside of electronics module.

Fig. 69: Bottom view of electronics module

- Remove screw **G** from intermediate plate behind insulation.

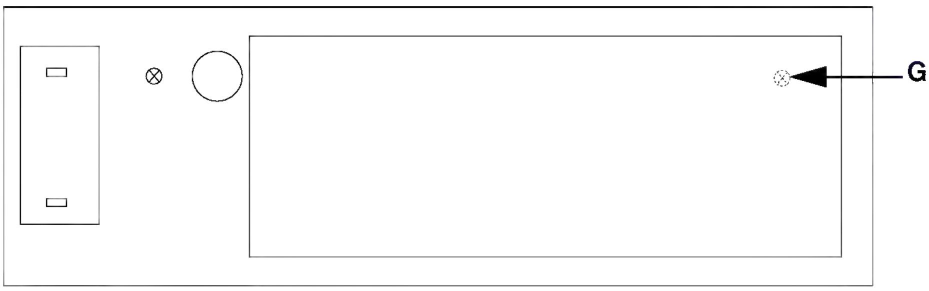


Fig. 70: Insulation of intermediate plate

- Remove plug contact **H**.

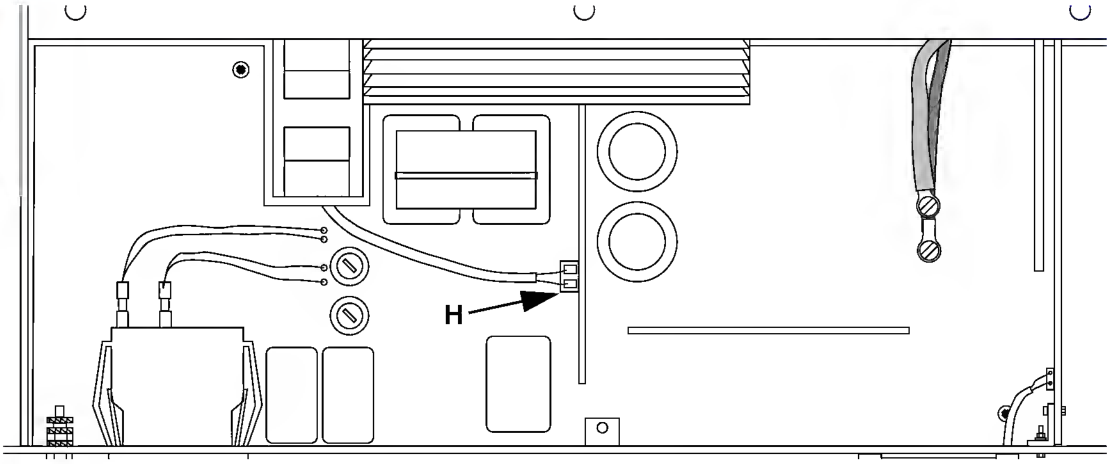


Fig. 71: Power supply to internal fan

- Note installation position of fan.
- Press intermediate plate slightly to rear and remove fan.
- Mount new fan in reverse order of that used for dismounting.
- Carry out safety and function tests according to Test Certificate.

32.8 Replacing Automatic Circuit Breaker (power supply unit 8601619 only)

32.8.1 Power Supply Unit "Ver01" through "Ver03"

- Switch off Julian.
- Pull power plug out of AC outlet.
- Remove power supply unit. Follow the safety precautions described under 32.1 "Safety Precautions".
- Remove screws **A** from power supply unit cover.

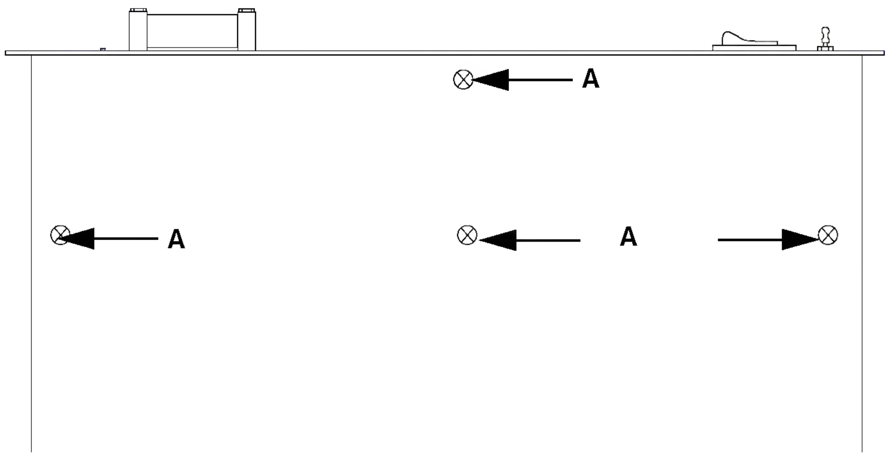


Fig. 72: Power supply unit cover

- Remove power supply unit cover.
- Applies to power supply units versions "Ver01" and "Ver02":
  Set automatic circuit breaker to OFF by pressing down lever **B**.

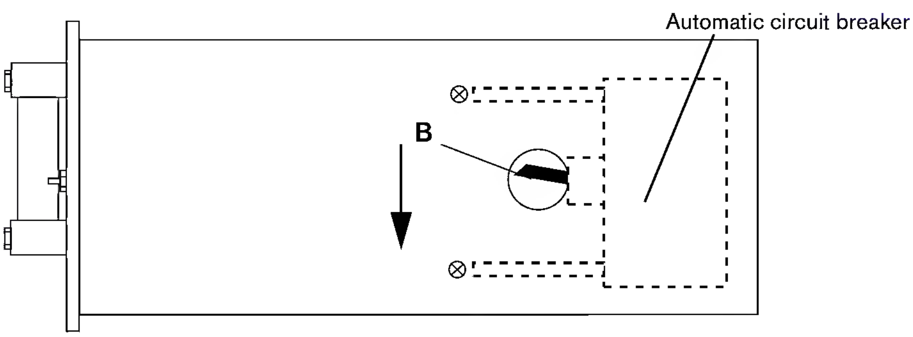


Fig. 73: Side view of power supply unit with automatic circuit breaker

- Applies to power supply unit "Ver03":
  Set automatic circuit breaker to position OFF by pressing down lever **C**.
- Remove screws **D**.

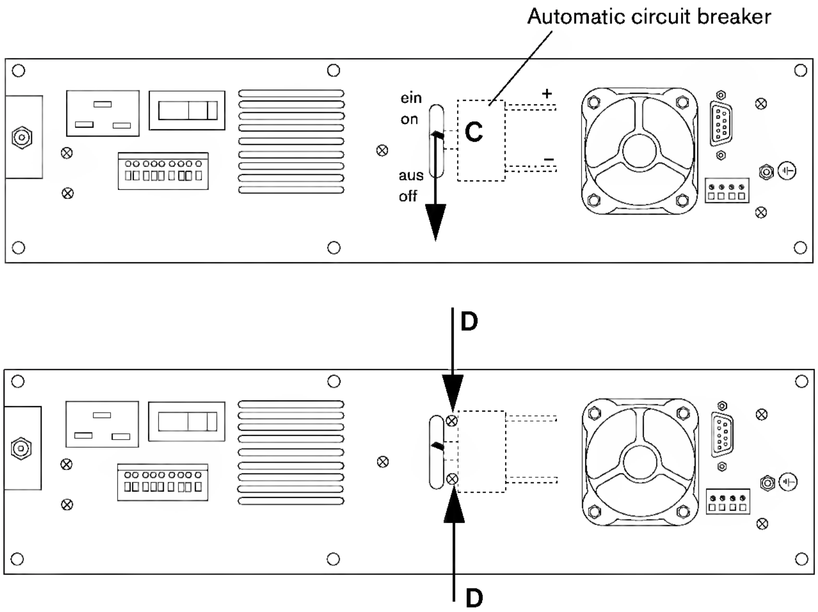


Fig. 74: Side view of power supply unit "Ver03"

- Disconnect cable from battery negative terminal (blue cable).
- Disconnect cable from battery positive terminal (red cable).
- Remove three fastening screws **E** from underside of power supply unit.

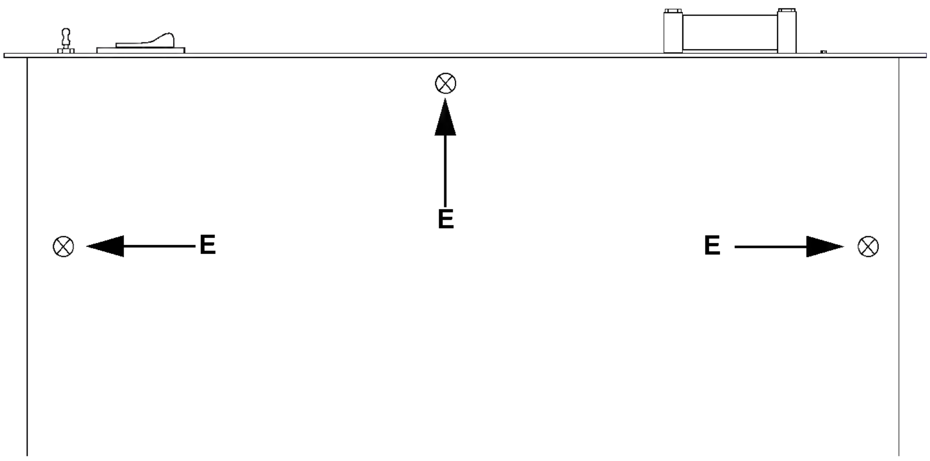


Fig. 75: Bottom view of power supply unit

- Remove four fastening screws **C** from front panel.

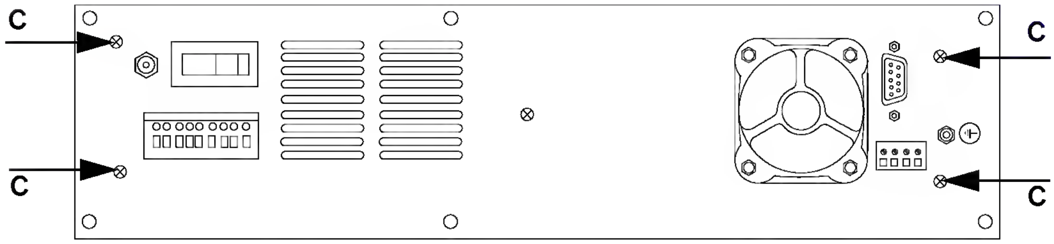


Fig. 76: Detaching front panel

- Remove four fastening screws **D** from intermediate plate.

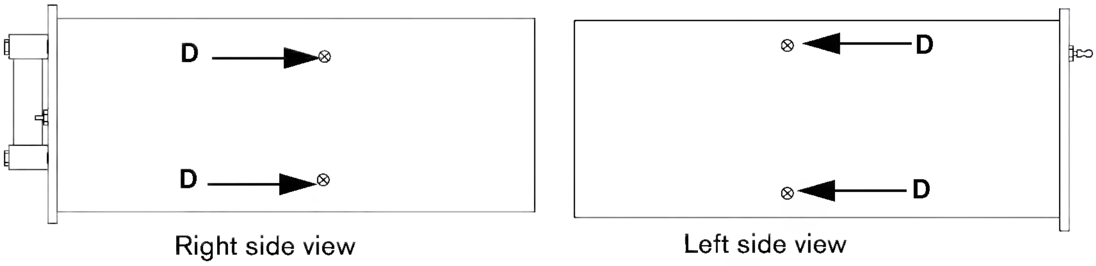


Fig. 77: Securing the intermediate plate

- Remove electronics module from power supply unit housing.
- Remove screws **E** from intermediate plate (one is located behind insulation).

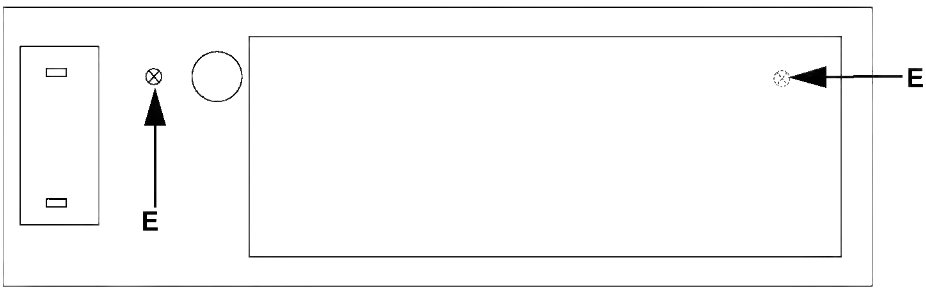


Fig. 78: Insulation of intermediate plate

- Remove intermediate plate.

- Disconnect connecting cables **F** from automatic circuit breaker.

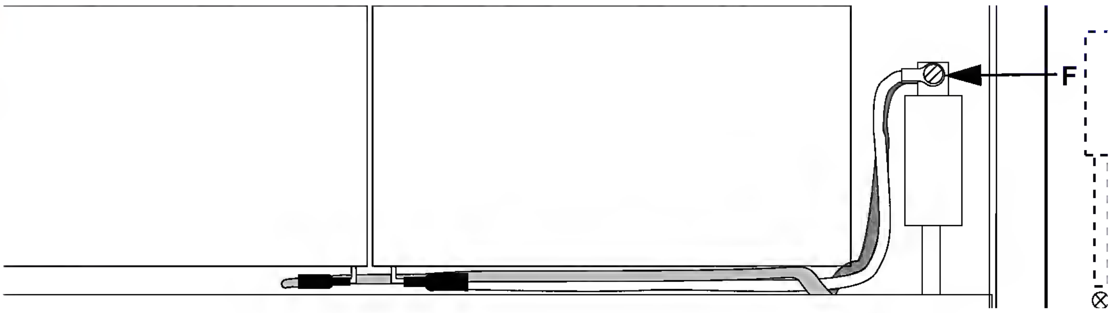


Fig. 79: Connecting cables from automatic circuit breaker

- Note installation position of automatic circuit breaker.
- Remove fastening screws of automatic circuit breaker.
- Remove automatic circuit breaker.
- Mount new automatic circuit breaker using the reverse order of that used for dismounting the old one.
- Carry out safety and function tests according to Test Certificate.

32.8.2 Power Supply Unit "Ver03" or Later

- Switch off Julian.
- Pull power plug out of AC outlet.
- Remove power supply unit. Follow the safety precautions described under 32.1 "Safety Precautions".
- Remove screws **A** from power supply unit cover.

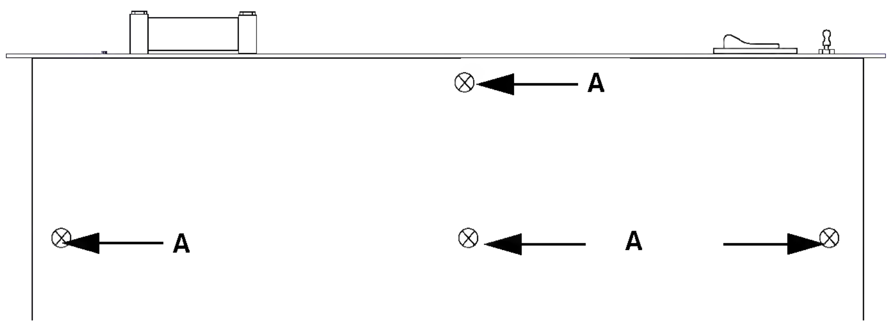


Fig. 80: Power supply unit cover

- Remove power supply unit cover.

- Disconnect cable from battery negative terminal (blue cable).
- Disconnect cable from battery positive terminal (red cable).
- Set automatic circuit breaker to OFF by pressing down lever **C**.
- Remove screws **D**.

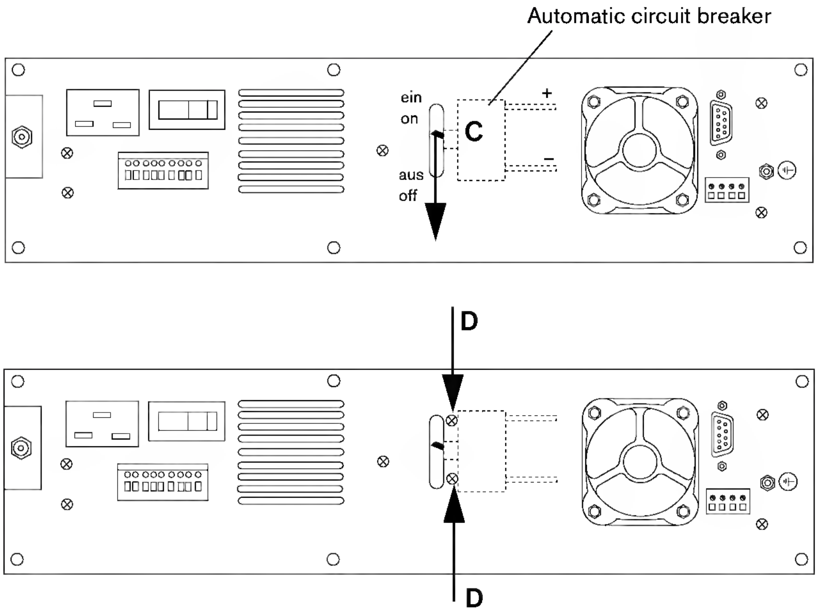


Fig. 81: Side view of power supply unit "Ver03" or later

- Disconnect connecting cables from automatic circuit breaker.
- Remove automatic circuit breaker.
- Mount new automatic circuit breaker using the reverse order of that used for dismounting the old one.
- Carry out safety and function tests according to Test Certificate.

32.9 Replacing Power Switch

- Switch off Julian.
- Pull power plug out of AC outlet.
- Remove power supply unit. Read and follow the safety precautions described under 32.1 "Safety Precautions".
- Remove screws **A** from power supply unit cover.

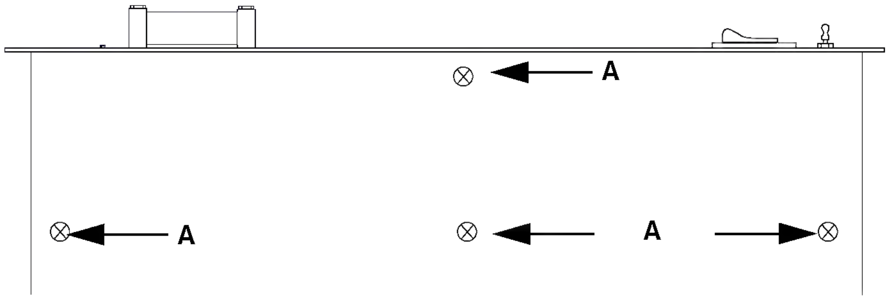


Fig. 82: Power supply unit cover

- Remove power supply unit cover.
- Note contact assignment of power switch.
- Disconnect cables **B** from power switch.
- Squeeze clips **C** at power switch together and remove power switch.

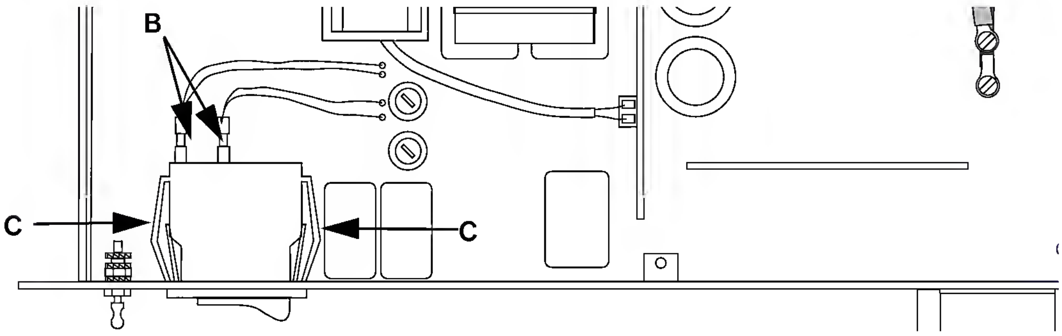


Fig. 83: Removing power switch

- Mount new power switch using the reverse order of that used for dismounting the old one.
- Carry out safety and function tests according to Test Certificate.

32.10 Replacing SLIO PCB

- Switch off Julian.
- Pull power plug out of AC outlet.
- Remove power supply unit. Follow the safety precautions described under 32.1 "Safety Precautions".
- Remove screws **A** from power supply unit cover.

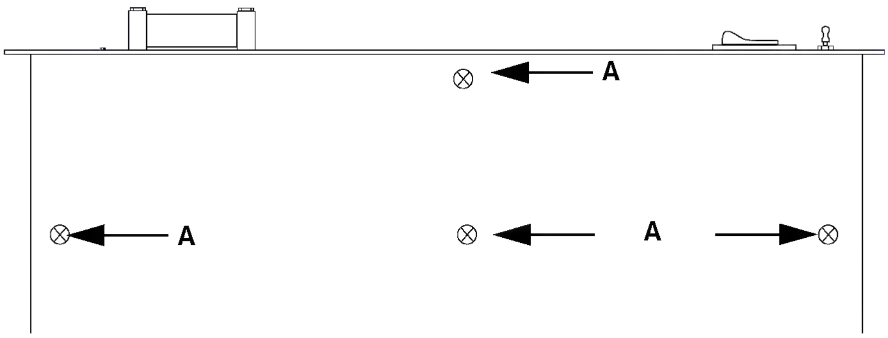


Fig. 84: Power supply unit cover

- Remove power supply unit cover.
- Applies to power supply units 8601619 up to and including "Ver02":
  Set automatic circuit breaker to OFF by pressing down lever **B**.

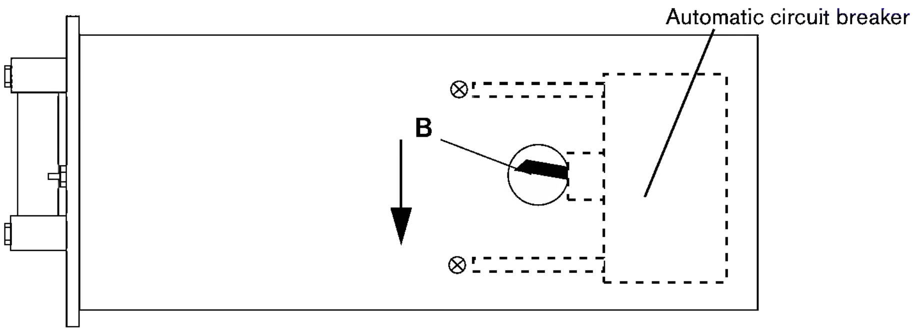


Fig. 85: Side view of power supply unit with automatic circuit breaker

- Applies to power supply units 8601619 "Ver03" or later:
  Set automatic circuit breaker to position OFF by pressing down lever **C**.

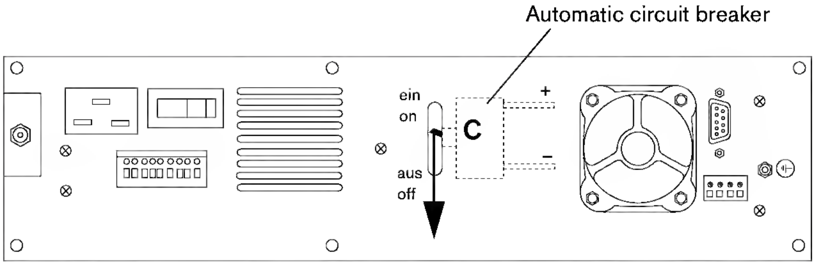


Fig. 86: Side view of power supply unit with automatic circuit breaker

- Applies to power supply unit 8601765:
  Disconnect supply conductors from external batteries.
- Disconnect connector **C** from SLIO PCB.
- Remove both fastening screws **D** of the "data socket".

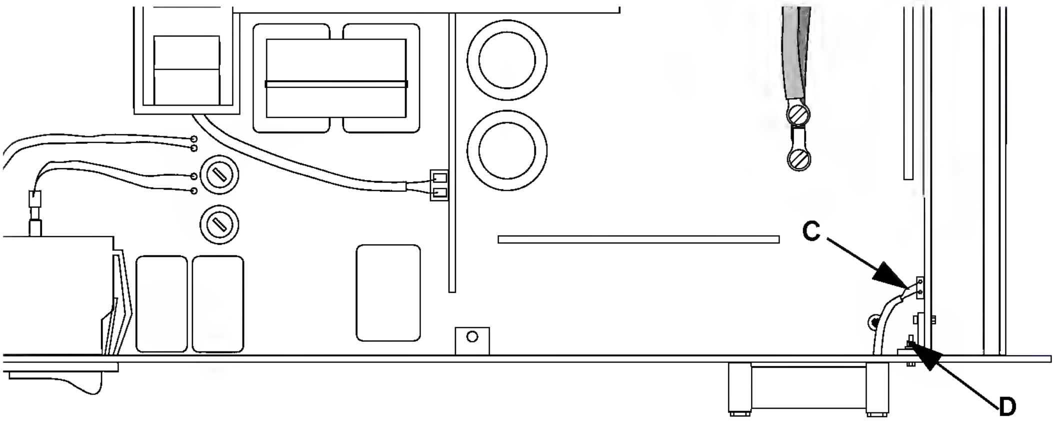


Fig. 87: External fan connection

- Remove five fastening screws **E** from front panel.

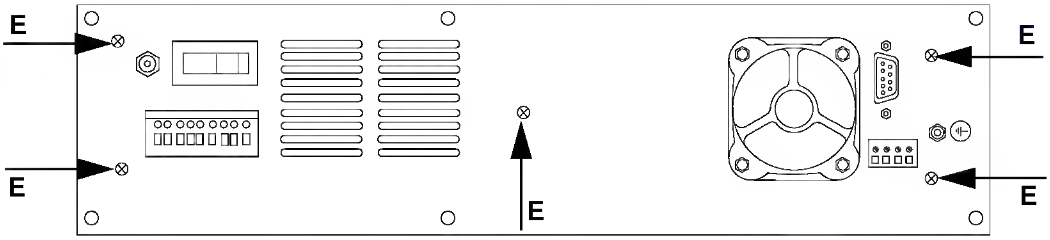


Fig. 88: Detaching front panel

- Fold front panel down.
- Remove two fastening screws **F** from intermediate plate and remove intermediate plate.

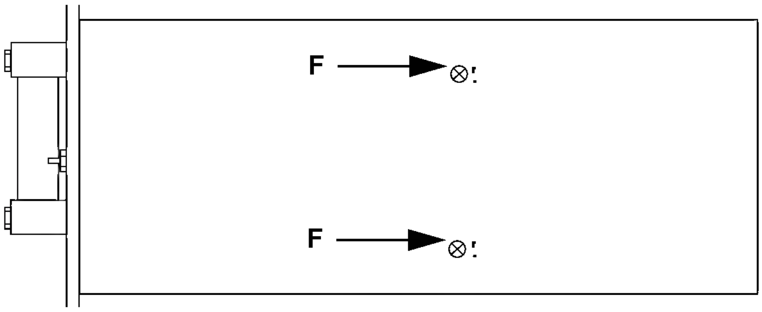


Fig. 89: To remove the SLIO PCB detach the intermediate plate.

- Press intermediate plate slightly to rear and remove SLIO PCB.
- Mount new SLIO PCB using the reverse method of that used for dismounting.
- Carry out safety and function tests according to Test Certificate.

32.11 Repair Information

32.11.1 Automatic Circuit Breaker (applies to power supply unit 8601619 only)

The automatic circuit breaker must always be set to ON. Otherwise no power will be supplied to Julian in the case of power failure.

The automatic circuit breaker connects the positive terminal of the battery to the power supply unit electronics. In the event of excessive current flow (e.g. short circuit) the automatic circuit breaker interrupts the connection.

The automatic circuit breaker is located in the top of the power supply unit and can be actuated through a hole in the side wall (for correct position refer to sticker, "see "Fig. 65: Side view of power supply unit with automatic circuit breaker" on page 121").

32.11.2 Batteries

New batteries do not have a sufficient charge. After replacing the battery or the power supply unit, Julian must be connected to an AC outlet for at least 10 hours in order to have a sufficient battery capacity in the event of power failure. It would be convenient to charge the batteries prior to installation.

32.11.3 Incorrect "mains failure!" Message

Error Description

If Julian is equipped with a power supply unit having a serial number less than 97020642, the following may occur sporadically:

a. "Mains failure!" error message is displayed although AC power is available.

b. "Mains failure!" message is **not** displayed although **no** AC power is available.

The manufacturer of the power supply unit has changed the design of the power supply unit. Power supply unit with serial number 97020642 and above will not cause the above error.

The power supply unit serial number can only be read after removing the power supply unit. The serial number can be found on the manufacturer's rating plate on the back of the power supply unit.

Error Causes

Julian's power supply unit monitors the mains voltage. This is done by a current detector located in Julian's power supply unit. If an incorrect AC voltage status is detected by the current detector, this is due to incorrect calibration by the power supply unit manufacturer.

Repair Procedure

Service Equipment

No.	Designation	Part No.
1	Measuring probe, red, pp 130	7901024
2	Measuring probe, black, pp 130	7901025
3	Measuring lead, red, 0.25 m	7900679
4	Measuring lead lead, black, 0.25 m	7900680
5	Digital multimeter, 3-digit	7901021

Procedure

- Switch off Julian.

Hazardous voltage. Risk of personal injury. Pull power plug out of AC outlet before servicing.

- Pull power plug out of AC outlet.
- Remove screws from rear panel and remove rear panel.

Hazardous voltage. A short circuit fault in the two power cables (power supply unit to DC/DC converter) will result in sparking and cause irreversible damage to power supply unit and rechargeable batteries. Voltage is still present even with power plug pulled out of AC outlet. **Always disconnect power cable from power supply unit first.**

- Disconnect data cable from power supply unit and DC/DC converter.
- Disconnect power cable from power supply unit and DC/DC converter.
- Remove the ground connection between the power supply unit and the DC/DC converter.
- Remove power supply unit. Follow the safety precautions described under 32.1 "Safety Precautions".
- Switch automatic circuit breaker of power supply unit to OFF.

Electrostatic discharge may damage electrostatic sensitive devices. **Always use a static-dissipative mat and a wrist strap** when handling electrostatic sensitive devices.

- Open power supply unit.

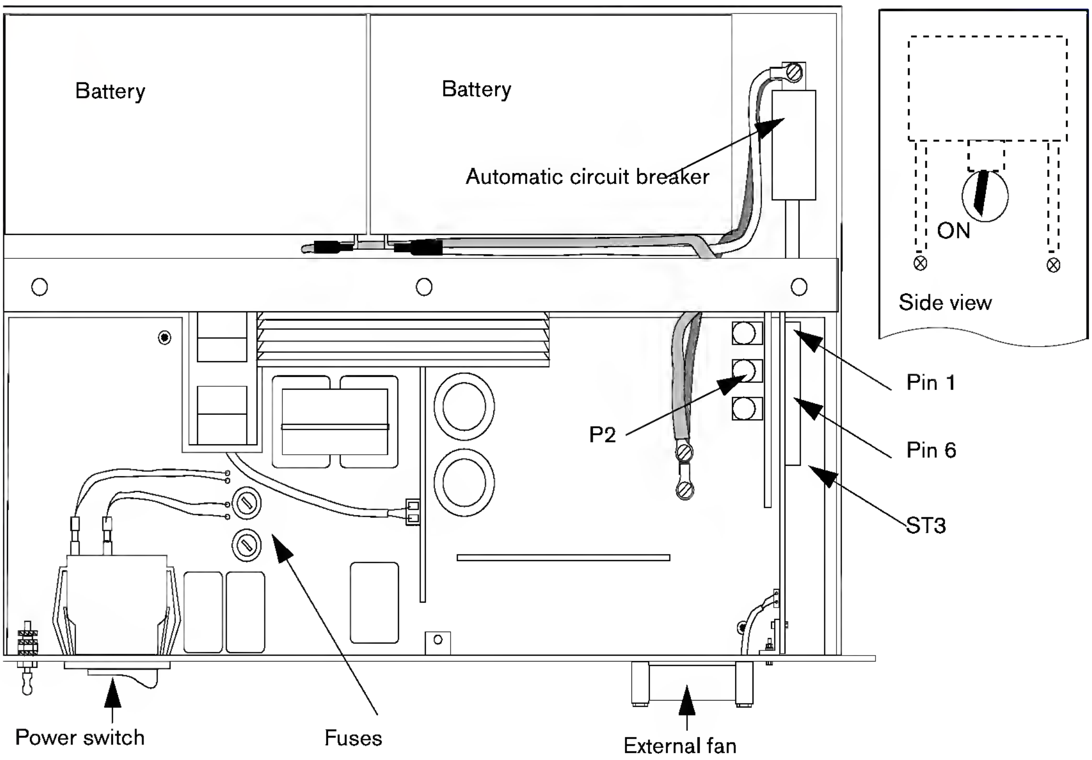
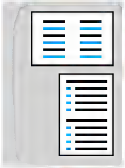


Fig. 90: Power supply unit components

- Connect black measuring probe (negative terminal) to pin 6 of plug connector ST3.
- Connect red measuring probe (positive terminal) to pin 1 of plug connector ST3.

Hazardous voltage.
Do not touch live conductors/parts when Julian's power plug is plugged into the AC outlet.

- Plug Julian's power plug into AC outlet
- Use center potentiometer P2 to set voltage across pin 1 and pin 6 to 200 mV ± 10 mV.
- Pull Julian's power plug out of AC outlet.
- Remove measuring probes.
- Close power supply unit.



If the **automatic circuit breaker** is set to **OFF**, Julian will not be supplied with power in the event of a power failure. **Always switch the automatic circuit breaker to ON**.

- Switch automatic circuit breaker of power supply unit to ON.

Caution:

During assembly, mount the 24 V power cable first, then the data cable.

- Assemble Julian using the reverse order. Tighten 2.5 mm screws carefully!

Final Tests

- Perform safety tests according to Julian Test Certificate.
- Connect Julian to pipeline system and AC outlet.
- Switch Julian ON and run complete self test.
- While Julian is in standby mode, pull Julian's power plug out of AC outlet.

Within 30 seconds, the battery symbol in top right corner of display screen should start to flash.

- Plug Julian's power plug into AC outlet.

Within 30 seconds, the battery symbol in top right corner of display screen should disappear.

32.11.4 Sporadic Occurrence of Safety Mode

Error Description

After switching Julian ON or confirming the self test check list, Julian sporadically goes into safety mode.

Error Cause

1. DC/DC converters with serial numbers lower than 98082640 have an incorrectly dimensioned resistor R67. This resistor defines the working point of an optocoupler. The optocoupler provides the electrical isolation of the power switch status signal between the power switch and the VentDos Controller PCB. An incorrectly dimensioned resistor can lead to sporadic changes in the power switch status detected by the VentDos Controller PCB or CIO PCB. As a result, Julian goes into safety mode.
2. Overheating the power switch during assembly of the cable will increase the contact resistance of the two power switch contacts for the power switch status signals of the VentDos Controller PCB and CIO PCB. If the contact resistance exceeds 3 Ω sporadic changes in the power switch status detected by the VentDos Controller PCB or CIO PCB may occur. As a result, Julian goes into safety mode.

Repair Procedure

- Switch off Julian.

Hazardous voltage. Risk of personal injury. Pull power plug out of AC outlet before servicing.

- Pull Julian's power plug out of AC outlet.
- Unscrew rear panel.

Hazardous voltage. A short circuit fault in the two power cables (power supply unit to DC/DC converter) will result in sparking and cause irreversible damage to power supply unit and rechargeable batteries. Voltage is still present even with power plug pulled out of AC outlet. **Always disconnect power cable from power supply unit first.**

- Remove DC/DC converter. Follow the safety precautions described under 32.1 "Safety Precautions".
- Remove cover of DC/DC converter.

Electrostatic discharge may damage electrostatic sensitive devices. **Always use a static-dissipative mat and a wrist strap** when handling electrostatic sensitive devices.

- Remove screws which hold DC/DC converter front in place and remove DC/DC converter front to access DC/DC converter main board.
- Remove fastenings screws which hold main board in place.
- Place main board, components side down, on static-dissipative mat.
- (Refer to figure below) Mount wired resistor 825 Ω, 0.125 W (P/N 1805312) in parallel to existing resistor on component side of main board.

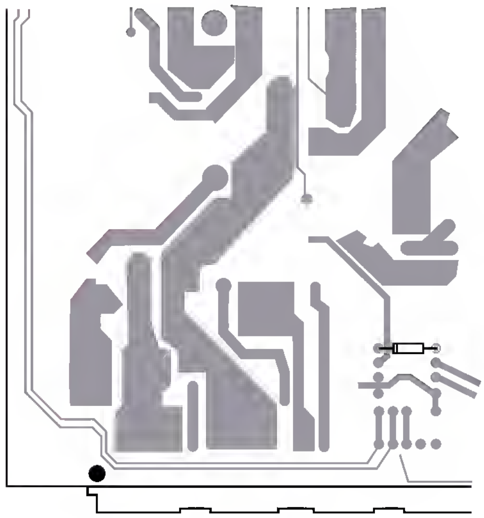


Fig. 91: Layout side of the DC/DC converter main board

- Mount DC/DC converter main board using the reverse method of that used for dismounting.
- Set Julian power switch to ON.
- Measure contact resistance across contacts 21C and 22C of lower DC/DC converter connector on motherboard.

Contact resistance should be below 3 Ω.

- If contact resistance exceeds 3 Ω, replace power switch (order no. 8601079).

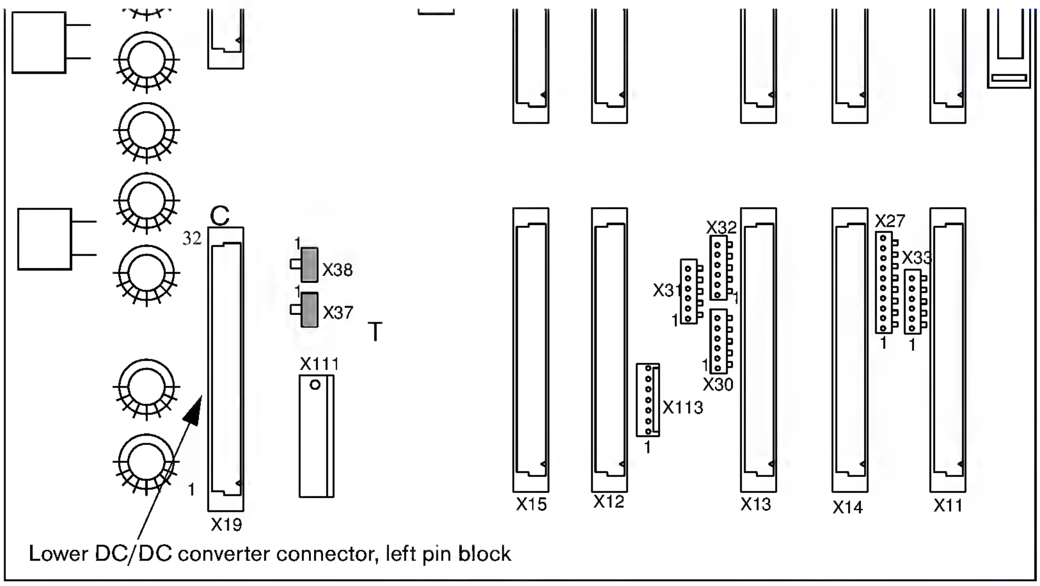


Fig. 92: Motherboard

- Remove CIO PCB from monitor plug-in module.
- Insert extender board (7901631) into slot of CIO PCB.
- Measure contact resistance across contacts X2/27A and X2/27C of lower CIO PCB connector.

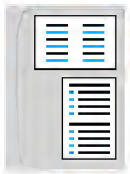
Contact resistance should be below 3 Ω.

- If contact resistance exceeds 3 Ω, replace power switch (order no. 8601079).
- Set Julian power switch to OFF.
- Mount CIO PCB into monitor plug-in module.

Caution:

During assembly, mount the 24 V power cable first, then the data cable.

- Mount DC/DC converter into Julian.
- Using existing screws, secure rear panel to Julian.



Final Tests

- Perform safety tests according to Julian Test Certificate.
- Connect Julian to pipeline system and AC outlet.
- Switch Julian ON and run complete self test.
- Switch off Julian.

33 DC/DC Converter

33.1 Electrostatic Precautions

Electrostatic discharge may damage electrostatic sensitive devices. **Always use a static-dissipative mat and a wrist strap** when handling electrostatic sensitive devices.

When dismounting the power supply unit or the DC converter make sure to disconnect the data cable first.

Only then may you disconnect the 24 V power cable between the power supply unit and the DC converter.
When mounting the devices, always connect the 24 V supply cable first and make sure all cables are secured properly. Only then may you mount the data cable. A wrong sequence may irreversibly damage the DC converter.

33.2 DC/DC Converter Connector Pin Assignment

33.2.1 Input Connector

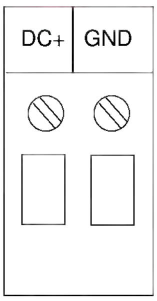


Fig. 93: DC/DC converter to power supply unit connector

Input voltage	
Pin	Assignment
DC+	18.5 V to 30.5 V
GND	Ground

33.2.2 Output Connectors

All output voltages are short-circuit-proof and stable at no-load. Output voltages are electrically isolated (Uiso = 500 V, Uiso for 24 V = 2.5 KV). ±15 V output voltages have a common ground. Voltages can be measured at the following connectors on the motherboard:

Monitor output voltages -> at X4, X14, X36 (see " "Voltages at Connectors X4, X14, and X36" in Electronics Repair Instructions").

Ventilator output voltages -> at X14 (see " "Voltage Supply to Actuator PCB" in Pneumatics Repair Instructions").

Monitor output voltages (top connector)	
Pin	**Assignment**
1 to 5 a/c	DGND
6a/c	5V-Sense –
7 to 11 a/c	+5.15 V ±0.15 V
12 a	5V-Sense +
12 c	Powerfail
13 to 16 a/c	12 V GND
17 to 20 a/c and 21 to 22 c	+12 V ±0.5 V
21 to 22 a	15 V GND
23 a/c	+15 V ±0.5 V
24 a/c	–15 V ±0.5 V
27 to 29 a/c	24 V GND
30 to 32 a/c	+24 V ±2 V

Ventilator output voltages (bottom connector)	
Pin	**Assignment**
1 to 5 a/c	DGND
6 a/c	5V-Sense –
7 to 11 a/c	+5.15 V ±0.15 V
12 a	5V-Sense +
12 c	Powerfail
13 to 14 a/c	AGND
15 a/c	+15 V ±0.5 V
16 a/c	–15 V ±0.5 V
18 a/c	GND
19 a/c	CAN +
20 a/c	CAN –
21 a	Anode (NTP+)
21 c	Key +
22 a	Cathode (NTP–)
22 c	Key –
23 a/c	Interlock +
24 a/c	Interlock –
25 a/c	StatusTa +
26 a/c	StatusTa –
27 to 29 a/c	24 V GND
30 to 32 a/c	+24 V ±1 V

33.3 Replacing DC/DC Converter

- Switch off Julian.
- Remove screws **A**.
- Loosen screw **B**.

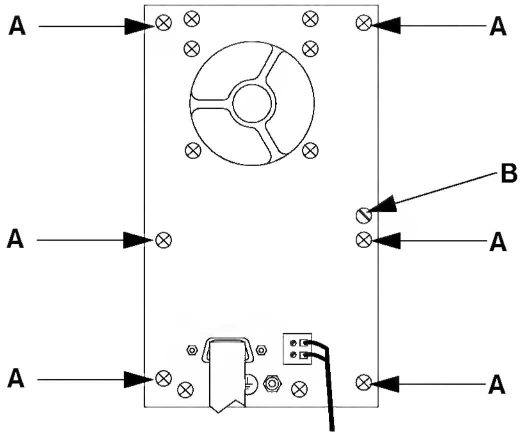


Fig. 94: Removing DC/DC converter

Hazardous voltage. A short circuit fault in the two power cables (power supply unit to DC/DC converter) will result in sparking and cause irreversible damage to power supply unit and rechargeable batteries. Voltage is still present even with power plug pulled out of AC outlet. **Always disconnect power cable from power supply unit first.**

When dismounting the power supply unit or the DC converter make sure to disconnect the data cable first.

Only then may you disconnect the 24 V power cable between the power supply unit and the DC converter.
When mounting the devices, always connect the 24 V supply cable first and make sure all cables are secured properly. Only then may you mount the data cable. A wrong sequence may irreversibly damage the DC converter.

- Remove the data cable **D** between the power supply unit and the DC/DC converter first.
- Disconnect connecting cable **C** from power supply unit.
- Remove the ground cable **E** between the power supply unit and the DC/DC converter.

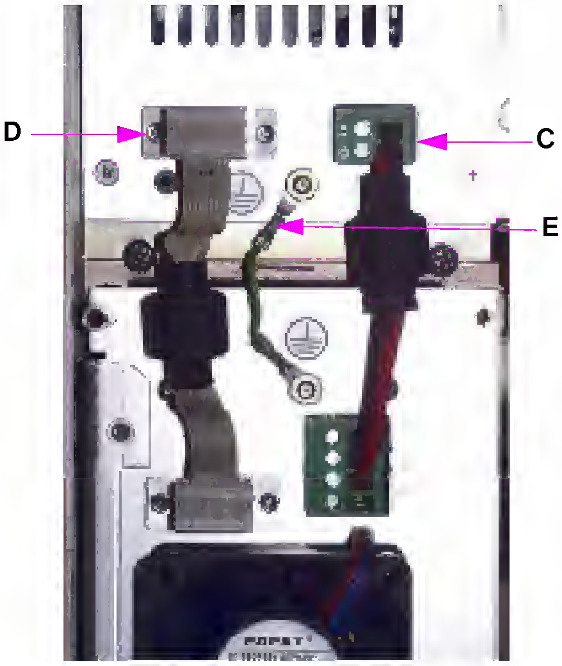
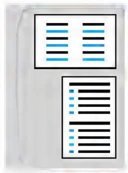


Fig. 95: Disconnecting cables

- Remove DC/DC converter. Read and follow the safety precautions under 33.1.
- Mount new DC/DC converter using the reverse method of that used for dismounting.
- Carry out safety and function tests according to Test Certificate.



33.4 Replacing Fan

The fan only runs when Julian is switched ON.

- Switch off Julian.
- Remove screws **A**.
- Loosen screw **B**.

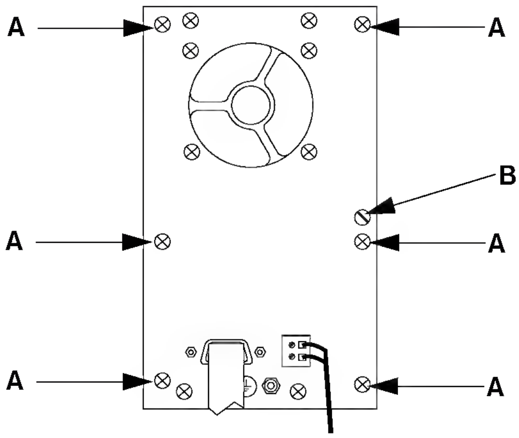


Fig. 96: Removing DC/DC converter

Hazardous voltage. A short circuit fault in the two power cables (power supply unit to DC/DC converter) will result in sparking and cause irreversible damage to power supply unit and rechargeable batteries. Voltage is still present even with power plug pulled out of AC outlet. **Always disconnect power cable from power supply unit first.**

- Remove the data cable **D** between the power supply unit and the DC/DC converter first.
- Disconnect connecting cable **C** from power supply unit.
- Remove the ground cable **E** between the power supply unit and the DC/DC converter.

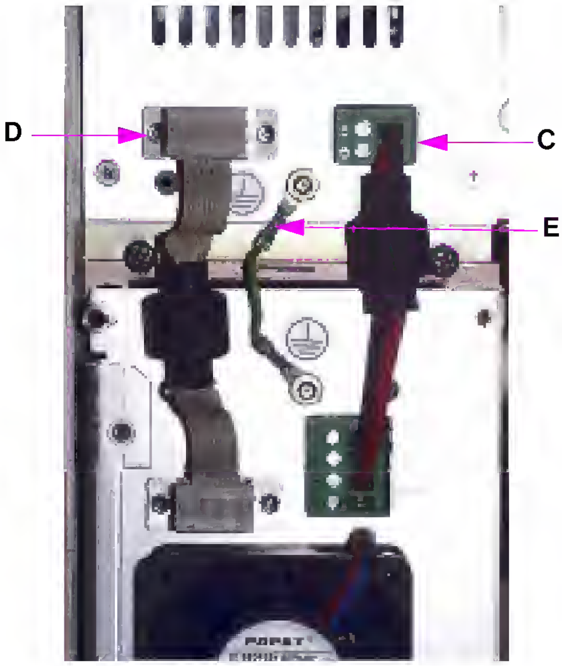


Fig. 97: Disconnecting cables

- Remove DC/DC converter. Read and follow the safety precautions under 32.1 "Safety Precautions".

- Remove fastening screws **E** from DC/DC converter.

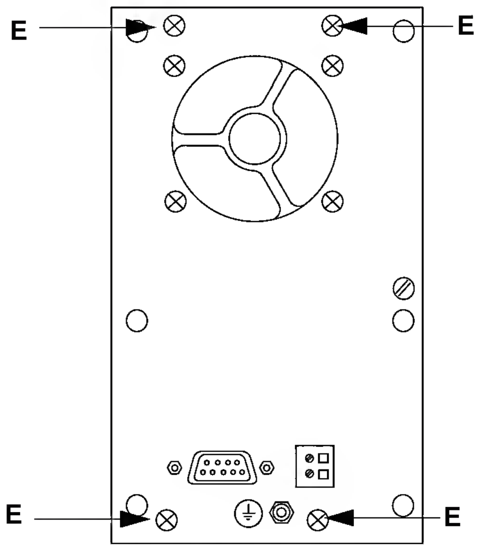


Fig. 98: Removing front panel

- Fold front panel down.
- Disconnect fan connector from motherboard.
- Note installation position of fan.
- Remove fan fastening screws.
- Remove fan.
- Mount new fan in reverse order of that used for dismounting.
- Carry out safety and function tests according to Test Certificate.

33.5 Repair Information

- - No entries -

34 IRIA Module

Contents

35 IRIA Module Repair Instructions

Unlike the Andros agent analyzer, the IRIA analyzer (IRIA) has 4 operating levels:

1. Start phase (S)
2. Reduced accuracy mode (R, available after approx. 2 minutes)
3. ISO accuracy mode (corresponds to F of Andros agent analyzer, available after approx. 4 minutes)
4. Full accuracy mode (F, available after approx. 20 minutes)

IRIA measures more accurately than the Andros agent analyzer. For this reason, the blue Andros agent analyzer hoses used to date can no longer be used, as they absorb anesthetics and give them off after a time delay.

IRIA cannot be re-calibrated (unlike the Andros agent analyzer). In the event of gas measurement deviations, it is, however, possible to carry out a "Service zero" in the field. For this purpose, depressurized O_2 is fed into the sampling hose and the "Service zero" step is carried out in the IRIA service program.

35.1 Service LEDs

Service LEDs are available on the Flow PCB and Processor PCB. They indicate the status of the analyzer.

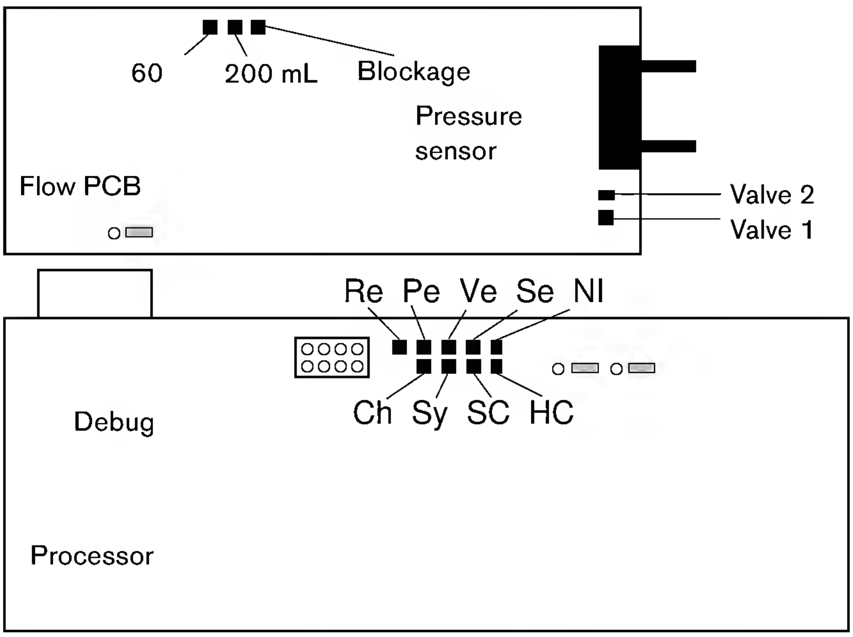


Fig. 99: IRIA service LEDs

Service LEDs:		
Re	Reset	ON during normal operation, OFF during reset
Pe	Pneumatics error	ON in the event of error (pumps, valves)
Ve	Voltage error	(+12 V,+15 V,+ 6.4 V)
Se	System error	Error log, LEDs, service program
NI	No ISO accuracy	Reduced accuracy
CH		Micro-controller has no controlling function.
Sy	Synch. Error	Motor speed error >1%.
SC	Source Contr.	Emitter control defective.
HC	Heater Contr.	Heater defective.

35.2 IRIA error log

Abnormal conditions in the IRIA are recorded by corresponding entries in the error log.

In the event of IRIA errors, read out the IRIA error log.

IRIA error log entries provide more details to the respective problems than the respiratory gas monitor error log entries.

As of Julian software version 3.0, the IRIA error log must be read out using the VISIA program (see "Reading out the IRIA error log as of software version 3.0 with VISIA" on page 158).

The IRIA error log is stored in the Timekeeper RAM (TKRAM) located on the Processor PCB. Therefore, you do not need to return the error log when sending back a complete IRIA. A printout of the error log is required when returning a defective IRIA sensor head.

The IRIA error log printout also shows statistics counters which contain the sum of error events (not evaluated in the field for the time being) as well as information about zeroing. Zeroing data appears at the end of the error log printout.

"Factory Zero Data" is data determined during manufacturing of IRIA. "Zero Data" is data determined during the most recent zeroing. A comparison of these two data sets allows you to detect any drift in the IRIA or contamination of the cuvette. If "Zero Data" deviates from the "Factory Zero Data" by more than 50%, error codes 35xx are entered in the error log.

35.2.1 Error log codes

In general, IRIA error log entries are divided in errors **11x** and **35xx**. Before returning IRIA for repair, you should search for the respective error using the error log.

Error codes **11xx** often indicate a defective sensor head.
Error codes **35xx** indicate a zero calibration error.

Table 4: Detailed Description of Error Codes

Hex	Symbolic Constant	Description
0000	Operating system error	**Send error log to Lübeck.** In case of multiple errors replace the Processor PCB.
0001		
0003		
0Axx		
1001 to 1005		
1007	Reset command received. Module restarted.	No action.
1008	Internal software error.	**Send error log to Lübeck.** In case of multiple errors replace the Processor PCB.
1009	No data from Oxigraf sensor. Oxigraf restarted.	**Send error log to Lübeck.** In case of multiple errors replace the Processor PCB and Oxigraf adapter.
1020 to 1030	Checksum error	In case of multiple errors replace the NVRAM.
1040	The two sensors on the MOPS PCB measure the same parameter (e.g. O2).	Should be taken as information. Repair not required. Report to HL, since this is a basic error of the module configuration.
1111	Module restarted.	No action.
1112	Module reset itself.	In case of multiple errors replace the module.
1113	The temperature of the filter wheel or smaple cell is ≥ 65 °C.	The sensor head was deactivated. Monitor internal temperature too high? **Fan mats? Otherwise send sensor head to Lübeck.**

Table 4: Detailed Description of Error Codes (cont'd)

Hex	Symbolic Constant	Description
1114	Sensor is in the ISO or F mode and light-source voltage is not OK.	Sensor head has been switched off. **Send sensor head to Lübeck.**
1115	IRIA sensor head error.	**Send sensor head to Lübeck.**
1116		
1117		Only with SW > 3.0. **Send sensor head to Lübeck.**
1118		Only with SW > 3.0. **Send sensor head to Lübeck.**
1119		**Send sensor head to Lübeck.**
111A	Only as information in connection with errors 1113 to 1119. 12 V supply voltage lies outside the valid range.	12 V supply: check this supply voltage. **Monitor power supply unit error.**
111B		
111C	15 V supply voltage lies outside the valid range.	Only with SW > 3.0. 15 V supply voltage lies outside the valid range. **Replace Processor PCB.**
111D		
111E	6,4 V supply voltage lies outside the valid range.	Only with SW > 3.0. 6.4 V supply voltage lies outside the valid range. **Replace Processor PCB.**
111F		
1200	Incorrect EEPROM checksum.	If all parameters (CO_2, O_2, etc.) can be measured and no further error occurs, it is not an extreme necessity to replace. Report to HL.
1201	Incorrect ROM checksum.	Reload software or replace Processor PCB.
1202	Incorrect calibration data.	**Replace sensor head (IRIA/ILCA).**
2111 to 2115		
2116		**Send error log to Lübeck.**
2117		In case of multiple errors replace the **Processor PCB. Faulty. Send error log to Lübeck.**
2118	Internal software error.	**Send error log to Lübeck.**

Table 4: Detailed Description of Error Codes (cont'd)

Hex	Symbolic Constant	Description
2180	One correction factor during spectral correction is zero. Therefore, correction cannot be carried out.	**Send error log to Lübeck. Replace module.**
2200	Water-trap self-test showed an error.	Either the optional water trap hardware is faulty or an older IRIA processor board type is fitted which has not been retrofitted yet (see conversion instructions to software version 2.05). **Otherwise replace Processor PCB**.
3111	The absolute pressure value is zero.	In case of multiple errors replace the module. **Send sensor head to Lübeck.**
3112	During conversion of pressure sensor voltage into a pressure value, the system detected that the corresponding table has not been calculated yet.	**Send sensor head to Lübeck.**
3113	Pressure sensor calibration data could not be read.	**Send sensor head to Lübeck.**
3114	EEPROM error	**Send sensor head to Lübeck.**
3115		
3116		
3117	Pressure sensor calibration error	**Send sensor head to Lübeck.**
3200	No pressure-sensor calibration data available.	General error while accessing EEPROM. **Send sensor head to Lübeck.**
3300	NOVRAM error.	**Replace TKRAM or battery. Replace Processor PCB.**
3400		No Factory Zero Data available on EEPROM. **Send sensor head to Lübeck**
3401	No zero values available on NOVRAM.	IRIA uses Factory Zero Data. Perform zeroing in the Full Accuracy Mode. **Replace TKRAM or battery. Replace Processor PCB.**
3402	Real-time clock error	In case of multiple errors replace the module.

Table 4: Detailed Description of Error Codes (cont'd)

<table>
<tr><th>Hex</th><th>Symbolic Constant</th><th>Description</th></tr>
<tr><td>3403 to 3408</td><td>Incorrect data from O2 sensor</td><td>Carry out 2-point span of the O2 sensor.</td></tr>
<tr><td>3420</td><td>a) Module was not started properly.

b) Incorrect configuration data on NVRAM.</td><td>Replace Processor PCB.</td></tr>
<tr><td>3501</td><td>FactoryZero was incorrect.</td><td>Send sensor head to Lübeck.</td></tr>
<tr><td>3502</td><td>Zeroing failed because not sufficient valid zero values could be detected (measurement, system zero?).</td><td>Sensor was in start-up mode. Possible causes: cuvette contaminated or faulty, valve defective (residual gas in the cuvette), light source defective. Send sensor head to Lübeck.</td></tr>
<tr><td>3503 to 3405</td><td>Zeroing failed.</td><td rowspan="3">Possible causes for zeroing failure: Dirty or faulty sample cell. Defective valve (residual gas in the sample cell). Defective light source.
Send sensor head to Lübeck.</td></tr>
<tr><td>3506 to 3509</td><td>Factory zeroing failed because not sufficient valid zero values could be detected (measurement, system zero?).</td></tr>
<tr><td>350A to 350D</td><td>Zeroing failed because values of one reference filter were outside permissible range.</td></tr>
<tr><td>350E to 3511</td><td>Zeroing failed because zero values deviate considerably from the factory zeroing. (compare Factory Zero and Zero Data at the end of the log)</td><td>Sensor was in start-up mode. Possible causes: cuvette contaminated or faulty, valve defective (residual gas in the cuvette), light source defective. Send sensor head to Lübeck.</td></tr>
</table>

Table 4: Detailed Description of Error Codes (cont'd)

Hex	Symbolic Constant	Description
3512 to 3515	Zeroing failed because measured values differ considerably.	Possible causes: **cuvette** contaminated or faulty, **valve defective** (residual gas in the cuvette), light source and/or detector defective. **Send sensor head to Lübeck.**
3516	Zeroing failed due to excessive negative pressure in pneumatic system during purging.	**Check hose system**. Obstructed? Hoses fitted incorrectly? Pressure sensor error? **Send sensor head to Lübeck**.
3517	Zeroing failed due to insufficient negative pressure in pneumatic system or positive pressure during purging.	This is often due to leaks, obstructed hose system or anesthetic-gas return line. **Sensor capsule fitted in O_2 adapter?** Valve defective, pump defective. Pressure sensor error?
3518 to 3520	Incorrect signal from O2 sensor	In case of multiple errors replace the O2 sensor.
3A11	Status of pump was not recognized correctly.	**Pump defective, Flow PCB defective**.
4000	Motor is blocked and will be switched off.	Only with SW > 3.0. Mostly only sequence errors of 11xx error codes. **Otherwise send sensor head to Lübeck.**
5000	Internal software error.	In case of multiple errors replace the module.
7000 to 700C	Errors with sensor-specific monitoring.	**Replace sensor head.** Sensor head must be restarted.
8000	Error with numerical filter. 1	**Send sensor head to Lübeck**
Fxxx	Internal software error.	Send error code to Lübeck.

35.3 Reading out the IRIA error log as of software version 3.0 with VISIA

Due to a new protocol, the error log cannot be read out as usual (IRIA status and calibration) as of software version 3.0. The following procedure describes how to read out the IRIA error log using the VISIA program.

Procedure:

Make sure the Julian is in Service Mode or Extended Service Mode.

- Press the "PC" key on the IRIA side.
- Interconnect the laptop and the Julian using the RS 232 extension (7901808). Connection from Julian Medibus interface COM2.
- Start the service software (version 9.3 or later) on the laptop. Start the VISIA program on the "PM 8050/60 Julian" side (for VISIA window, see the following figure).

The program automatically creates a connection to the Julian. If the connection needs to be created manually, press the "Connect" button (green marking). If communication between laptop and the IRIA is OK, a green lamp lights up and the message "VISIA connected" appears at the bottom left of the window (see Fig. 100:).

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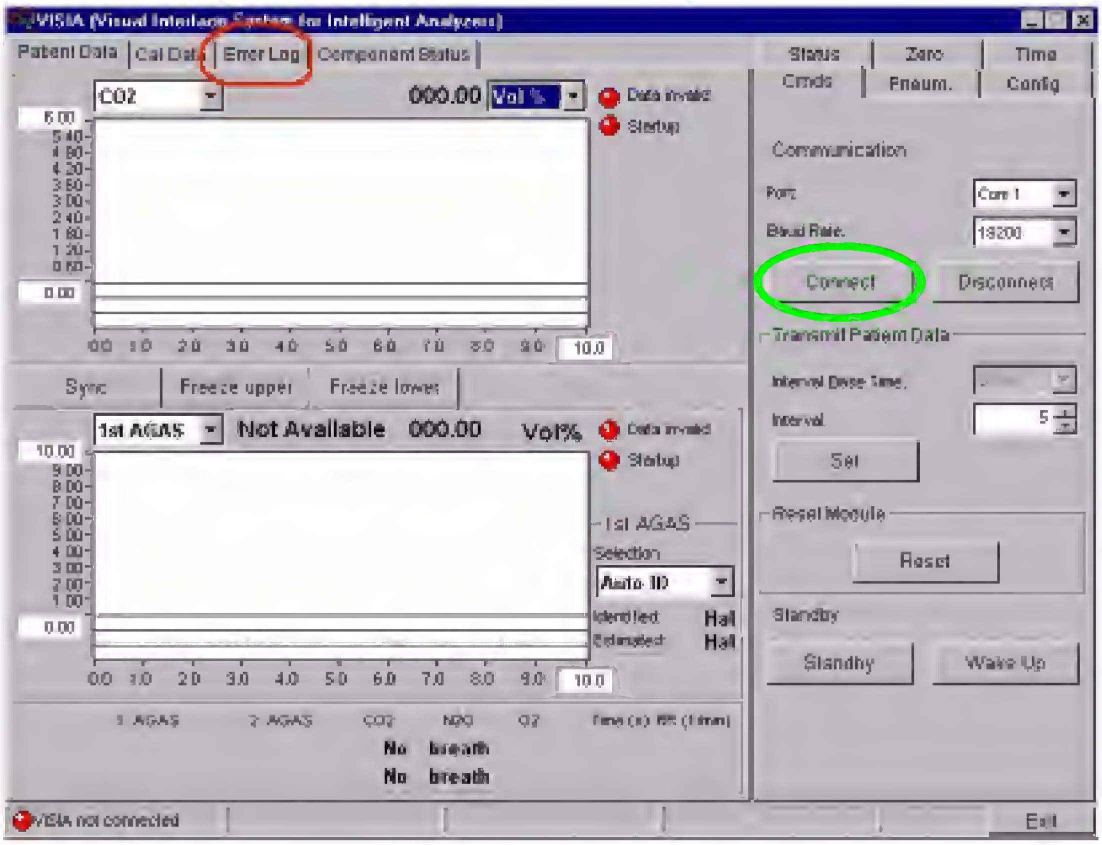


Fig.100: Start page of the VISIA program

- Select the "Error Log" tab (see Fig. 100:, red marking). The error log is read out automatically (see the following figure for an example of the log).

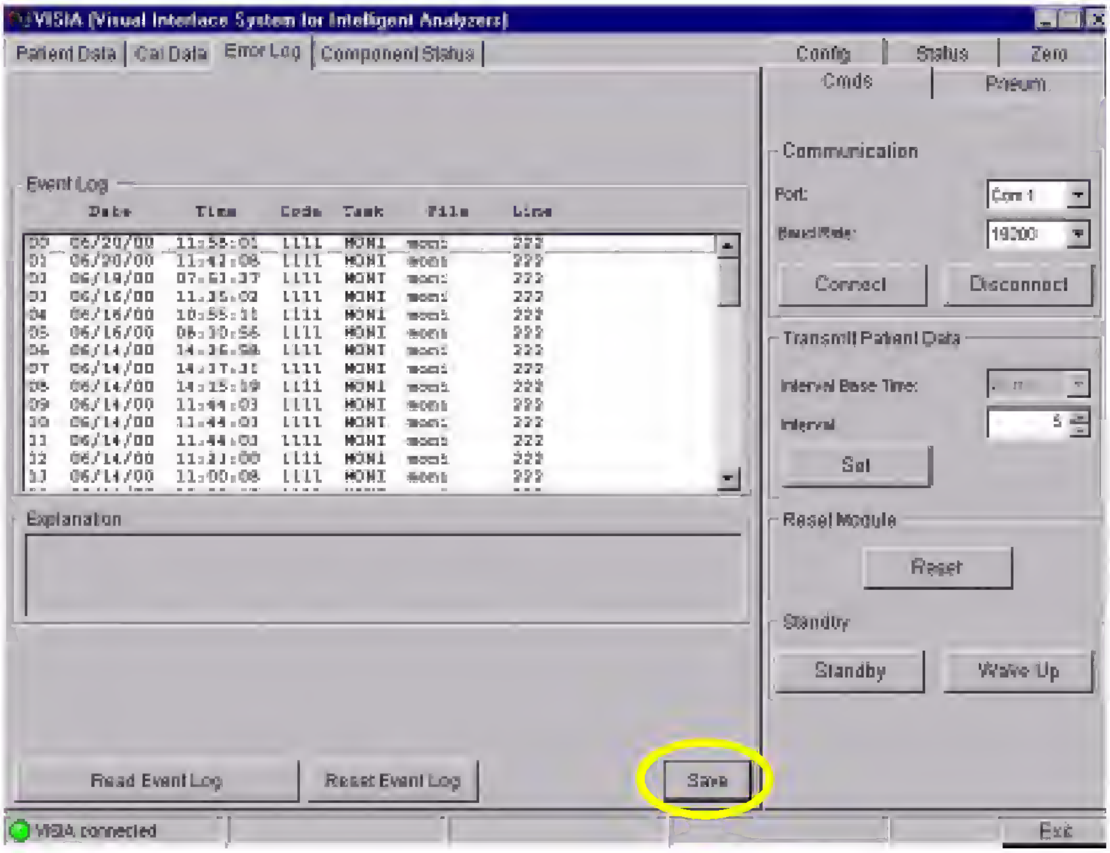


Fig.101: Error log page

- Press the "Save" button to save the error log (see Fig. 101:, yellow marking).
- After having saved the error log successfully, press the "PC" key on the IRIA side in Service Mode. Then shut down the laptop and remove the connection between the laptop and the Julian.

35.4 Download Program with Debug Adapter

The download program is used to download a new software version to IRIA if downloading with the external interface has failed. EPROM replacement is thus no longer necessary.

35.4.1 Service Equipment Required

– Laptop computer

– Download program with latest software version

– Debug adapter 79 01 980

35.4.2 Download with Debug Interface

- Connect debug adapter (79 01 980) to parallel interface of laptop computer.
- Connect other end of debug adapter to background debug interface of IRIA (refer to ""Connecting Debug Adapter to Processor PCB"").
- Switch Julian to "**Standby**".
- Select "**Andros menu**" in service mode and press "**PC**" key.

"PC" appears on bright background.

- Start "**Download**" program from floppy disk.

Several programs are now executed automatically (takes approximately 10 minutes). The program stops in the event of an error. If flash programming was successful, the system returns to DOS level.

- Switch off the monitor.
- Disconnect the debug adapter.
- Switch on the monitor.
- Select "**Andros menu**" in service mode.

IRIA logs on with new software version. After the start phase, GS byte indicates "00" (no error).

- Reassemble Julian ready for operation.
- Perform safety and functional tests according to Test Certificate.

Connecting Debug Adapter to Processor PCB

The debug adapter has a 10-pin connector.

The IRIA debug connector has 8 pins.

The red wire is connected; the two right-hand plug contacts are not used.

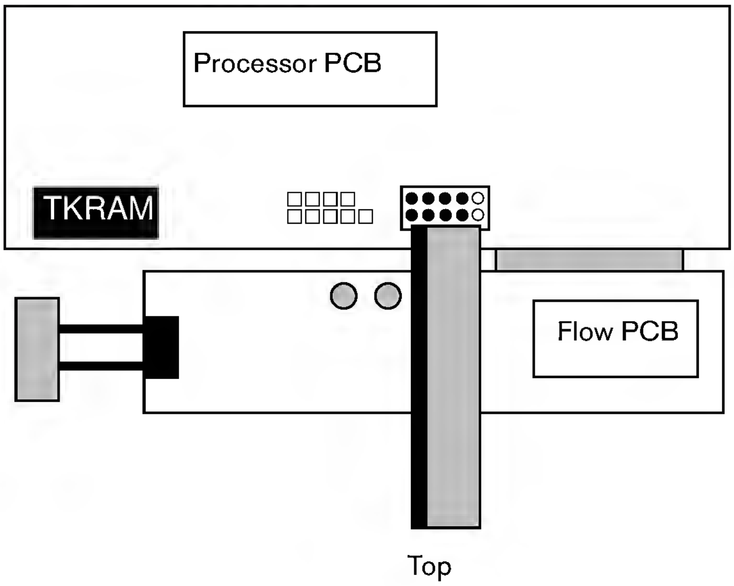


Fig.102: Connecting debug adapter to IRIA

35.5 Download Program with External RS232 Interface

- Switch Julian to "Standby" and select service mode.
- Use test cable RS232 extension 7901808 to connect PC with Julian (COM2).
- Start the service program (icon on windows desktop).
- Select "Download".
- Insert floppy disk with relevant program in PC drive.
- Select "Install new device software" (if not yet available on hard disk).
- Select relevant IRIA software version.

Download program starts automatically.

- Acknowledge displayed message by pressing "Y" on your laptop computer.
- Use "arrow-up" or "arrow-down" keys to select "downloadrequest".
- While in Julian service mode, open "IRIA menu" and select "PC" key.

Wait until "Linked to 9015 IRIA 02.XX:03.00" is displayed (if it is not displayed, quit the program using the "ESC" key and restart with "Call-up of service program").

- Press ENTER (to confirm).

"New value" is displayed (no entry required).

- Select "Take over old value" and press ENTER key (to confirm).

The following information should appear:

Selected	ID no.	Description
-(X)-	IRIASSSW	V2_XX.DLD IRIA FIRMWARE X.XX (X stands for version of respective software)

- Press ENTER (to confirm).

Download is carried out automatically. Wait until "Transfer of requested files completed" is displayed.

- Press ESC key and exit from service program.
- Switch off Julian.
- Disconnect test cable RS232 extension.
- Switch on Julian.
- Check IRIA in service mode (refer also to Test Certificate).

35.6 Replacing TKRAM (or Battery Pack)

35.6.1 Service Equipment Required

Laptop computer	
Service software > 7.0	
Communication cable	7901808

35.6.2 Procedure

- Switch off Julian.
- Remove Julian's rear panel.

Electrostatic discharge may damage electrostatic sensitive devices. **Always use a static-dissipative mat and a wrist strap** when handling electrostatic sensitive devices.

- Remove IRIA.
- Remove TKRAM (with DIL housing, applies to approximately 50 devices) or remove battery pack on TKRAM SMD.

The TKRAM is located on the Processor PCB underneath the restrictor.

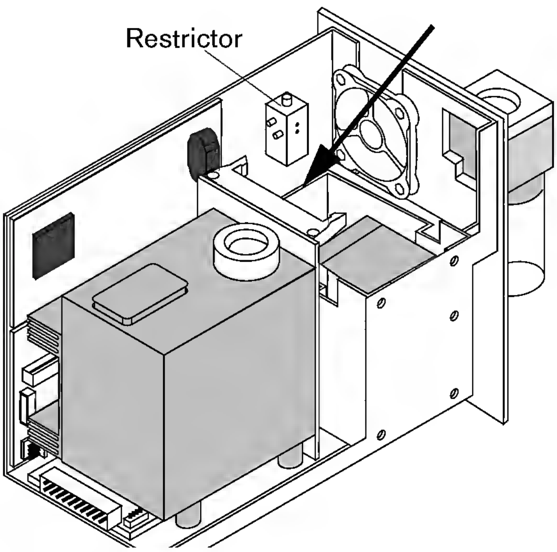
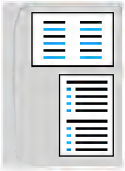


Fig.103: Replacing the TKRAM/battery pack in IRIA

- Mount the new TKRAM onto the Processor PCB or the battery pack onto the TKRAM SMD. Make sure the polarity of the TKRAM/battery pack is correct.
- Mount IRIA into Julian.
- Switch off Julian.
- Select "opt.bench" from service mode.
- Press the "PC" key.
- Connect laptop computer to Julian (COM 2).
- Start the service software.
- Select "PM8060/Julian" –> "IRIA status and calibration" –> "Set time" on laptop computer.
- Enter time and date (you do not need to enter the dot). Example: Time 07.30.00, date 05.11.96.



- Reassemble Julian ready for operation.
- Carry out safety and function tests according to Test Certificate.

35.7 IRIA tubing diagram

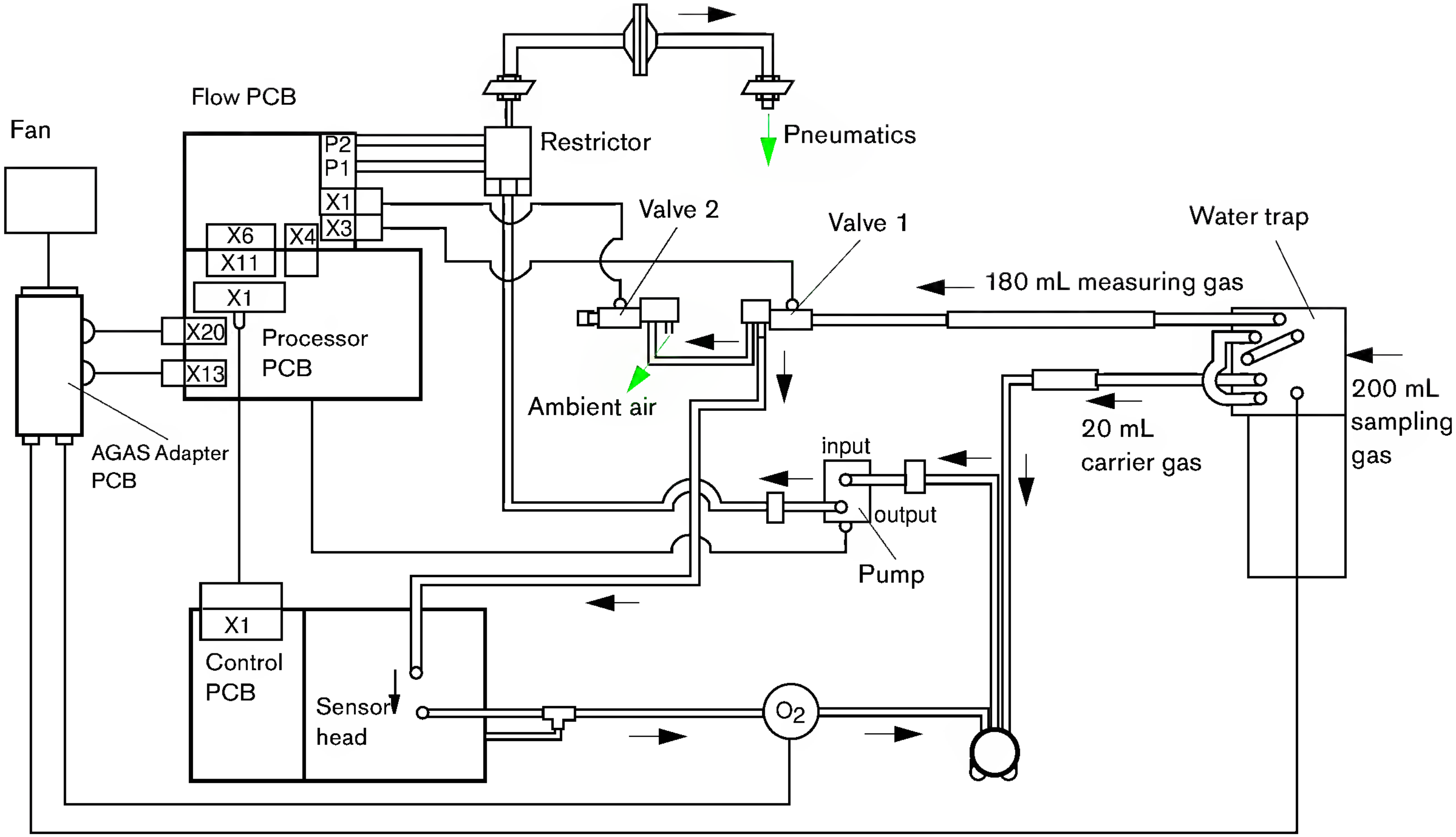


Fig.104: IRIA Tubing Diagram

35.8 IRIA hardware components

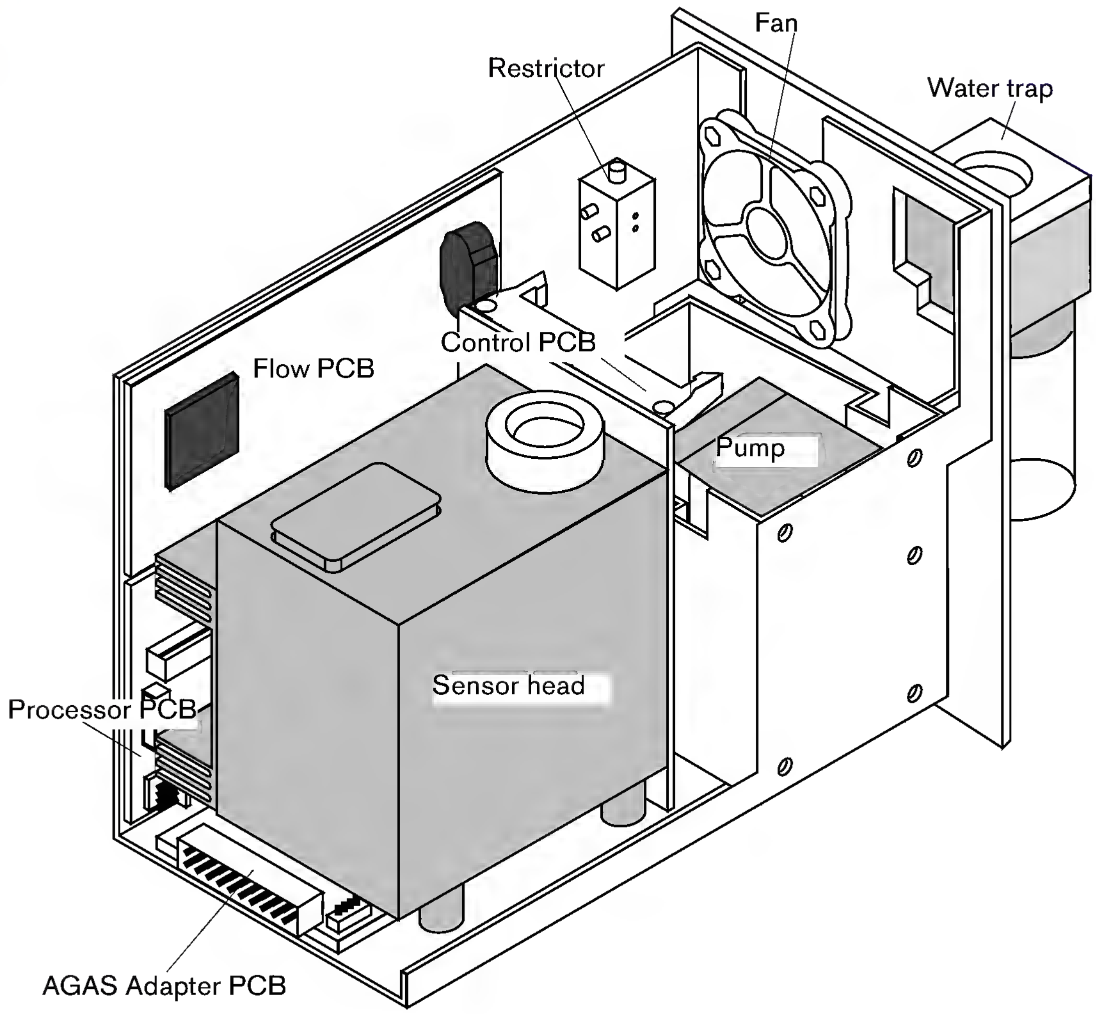


Fig.105: IRIA hardware components

35.9 IRIA Service Program

35.9.1 General

Communication between laptop computer and IRIA requires the monitor to be in the service mode. The menu "opt.bench" or "Andros" must be activated and the button "PC" pressed. Control of monitor over the agent analyzer is thus transferred to the laptop.

35.9.2 Communication with PM 8050/PM 8060 monochrome

Test cable 79 01 761 and test cable RS232 extension 79 01 808 are required to interconnect laptop computer and monitor. The cables are connected up between the serial interface of the laptop computer and the RS232 C (not the printer). Depending on equipment used, the laptop computer must communicate via COM2 (with built-in modem) or COM1 (no built-in modem).

35.9.3 Communication with PM 8060 Color

Test cable RS232 extension 79 01 808 is required to interconnect laptop computer and monitor. The cable is connected up between the serial interface of the laptop computer and the RS232 C (not the printer). Depending on equipment used, the laptop computer must communicate via COM2 (with built-in modem) or COM1 (no built-in modem).

35.9.4 Communication with Julian

Test cable RS232 extension 79 01 808 is required to interconnect laptop computer and Julian. The cable is connected up between the serial interface of the laptop computer and the COM2 (not the printer). Depending on equipment used, the laptop computer must communicate via COM2 (with built-in modem) or COM1 (no built-in modem).

35.9.5 Program Description

This text can also be found under menu item F1 (help) in the IRIA service program.

The IRIA service program includes the following:

– iria.exe (program file)
– h_iria.txt (menu texts)
– iria_hel.txt (help file)

Each window and each procedure can be terminated by pressing the ESC key. Selection (menu) can be made using the arrow keys and execution started by pressing the ENTER key.

The program responds with a standard screen in black and white or color depending on installation.

If installation is not correct, the file "iria.cfg" can be cancelled with the service program "change interface" and the program restarted.

Communication with the IRIA agent analyzer can be recognized by the running time/date.

35.9.6 Screen Masks

Name of agent analyzer

IRIA identification, revision number, serial number, date/time of IRIA agent analyzer and running time meter are displayed here.

Measured values

In addition to the measured values, the mask shows the anesthetic agent currently set in the IRIA agent analyzer.

Status

The status mask display a number of messages from the analyzer. These are listed below:

System error:

OK	: No errors reported
Error:	Agent analyzer reports general system error
Pyro Detec	: Optical detector defective
Light source	: Light source defective
Temp high	: Temperature emergency shutoff
Synchronous:	Filter wheel synchronization defective
Voltage	: Supply voltage incorrect
Cuvette	: Incorrect characteristic data in cuvette; possibly contaminated

Self-test:

OK	: No errors found during self-test
Clock	: Error in real-time clock sector of IRIA
EEPROM	: Checksum/EEPROM test not OK
TKRAM	: Checksum/TKRAM test not OK
FlashEPROM:	Checksum/FlashEPROM not OK
RAM	: RAM read/write test not OK
Water trap	: Error in water trap monitoring sector

Status:

OK	: IRIA agent analyzer status is OK
Zero meas	: IRIA measuring/calculating data for zeroing
Zero purge	: IRIA purging flow for zeroing
Zero fail	: Last zeroing of IRIA failed
Span1 meas	: IRIA measuring/calculating upper pressure point
Span2 wait	: IRIA waiting for lower pressure value
Span2 meas	: IRIA measuring/calculating lower pressure point

Span fail	: Last span correction failed
Temp high	: Heater system defective
!!Service!	: Flushing for service zeroing (approx. 30 s)

Accuracy:

Start	: IRIA in start phase. System error set. No measurement data.
Reduced	: Reduced accuracy. Switches to ISO accuracy only after zeroing.
ISO	: IRIA ready for operation. Calibration not yet possible.
Full	: IRIA has reached full accuracy.

Flow system:

OK	: Pump operating within control range
Error:	Desired flow not attained (obstruction)

Flow rate:

Off	: Pump off
Low	: Pump low-flow operation (60 mL/min)
High	: Pump high-flow operation (200 mL/min)
Flush	: Pump purge-flow operation (200 mL/min)

Zeroing:

Manual : If required, individual zeroing cycles can be started by pressing F4.
Necessary : IRIA has detected excessive drift. Zeroing required.
Automatic : Can be selected by pressing F4. Zeroing is carried out automatically as soon as requested by IRIA.

Channel limit:

Anesth. gas,
N2O,
CO2,
Pressure : Limits in channel OK or exceeded

Valve:

Ambient	: IRIA pump draws in ambient air
Patient	: IRIA pump draws in patient gas

Water trap, Julian:

OK : Water level low. Status OK.
Error: Water level is too high. Water trap is full. Automatic switching to ambient air.
This message is not generated in PM 8060.

Several interactive commands are available to the user, all of which can be selected using the arrow keys and executed by pressing the ENTER key. Windows can always be closed by pressing the ESC key.

F1. Help:

This text file. Scrolling backwards and forwards using arrow keys.

F2. Settings:

Menu containing all possible settings.

Setting O2 value:

An additional window for entry of current O2 value in vol.% opens. The value may be up to 100 vol.%. For 1/10 vol.% (if applicable), enter a "." or a "," first. Confirm correct value with ENTER or cancel wrong values with BACKSPACE. ESC terminates the procedure. IRIA calculates the O2 value for correction of cross-sensitivities.

Setting time:

An additional window for entry of the current time opens. The entry takes the form of a complete line for time and date. The entry can be edited using the BACKSPACE key. Confirm using the RETURN key or abort using the ESC key.

Adjusting flow:

IRIA allows you to adjust the gas flow. Such an adjustment only applies to the flow rate currently set. Adjustment is made using the arrow and +/- keys (slow) or using the Pageup/Pagedown keys (fast). The values can be stored by pressing the ENTER key. Pressing "Q" (quit) will terminate the adjustment and the values will only be stored temporarily (until switch-off). The previous flow can be reset using the ESC key. After pressing the ESC or RETURN key, IRIA switches the rate to OFF after several seconds.

Flow rates +/-:

The flow rates are selected from a menu. Selection is made using the arrow keys. Pressing the ESC key will abort the procedure, pressing the ENTER key will store the value.

Adjusting pressure: function not implemented yet

(The absolute pressure sensor of IRIA is the only channel which can be adapted. This involves setting 2 pressure ranges (refer to Test Certificate). "High" pressure is entered first. Enter in hPa (mbar). Press ENTER to confirm, press ESC to abort the procedure. Use the same procedure for "low" pressure).

Selecting the anesthetic agent:

The anesthetic agent is selected from a menu. Selection is made using the arrow keys. Pressing the ESC key will abort the procedure, pressing the ENTER key will store the value. The display in the measurement data window indicates the anesthetic agent reported by IRIA. If there is a difference between the anesthetic agent entered and that reported by IRIA, it may be that the IRIA has detected a different anesthetic agent.

Reset statistics:

This resets the counters for the statistical data of the error log. Resetting statistics is only appropriate after repair work or for special tests.

Reset IRIA (!):

An IRIA warm start is triggered. Depending on operating temperature, it may take several minutes until the device is ready for operation again.

Valve switching:

The IRIA valve can be switched between ambient air and patient air. The respective position is reported by status messages.

F3/ESC:

Exits the program. A prompt is displayed first. RETURN means "yes".

F4. Zeroing:

This will open a menu which allows you to switch the automatic zeroing mode ON/OFF or to carry out zeroing with ambient air or O2 (service zero). Automatic mode can switched by repeated selection. In automatic mode IRIA performs zeroing as soon as it detects a component drift.

F6. Error log:

This opens a display window which shows the individual IRIA error log entries. The arrow keys or Pagedown/Pageup keys can be used to scroll through the entries. Press ESC to quit.

If IRIA does not respond, the window must be closed by pressing ESC.

Pressing "S" will store the contents of the log on a floppy disk. The statistics log of the IRIA will also be stored on the floppy disk.

Entries in error log (in hex format):

Refer to F1 in IRIA service program or to the respective section of the repair instructions.

35.10 IRIA Module Repair Information

Electrostatic discharge may damage electrostatic sensitive devices. **Always use a static-dissipative mat and a wrist strap** when handling electrostatic sensitive devices.

35.10.1 IRIA Module, No Pump Flow

The pump in the IRIA module is switched off, and various error log codes in the IRIA error log display information concerning possible error causes.

Notice: The IRIA error log can only be read out using a laptop computer.

Error Causes

Power Supply to IRIA

Error log: 1117, 1119, 4000
Julian: all gases INOP

The +12 V power supply to IRIA from the Julian DC/DC converter is a possible cause of error. A voltage within a range of 11.0 V and 12.6 V is required as "+12 V" supply power by IRIA. In this case an error has occurred at the DC/DC converter in the Julian, not at IRIA. In 1996, 8 Julian units were shipped, for which supply output power from the DC/DC converter was set to 12.5 V to 13 V no-load voltage for the +12 V voltage supply. The affected units have the following serial numbers: ARKK 0062, ARKK 0068, ARKL 0025, ARKL 0029, ARKL-0031, and ARKN 0031.

Flow PCB Software

Error log: 3517 (zeroing failed; no vacuum at the cuvette)
Julian: at first, continuous activation of the zeroing sequence, then gas measurement INOP

Another possible cause of error can occur in the monitoring of pump voltage with the flow controller software. If the pump is operated at high load (increased flow resistance in the sampling line, contaminated water trap) and additional voltage surges occur in the supply line of the pump, the following may happen with flow controller software version 01.01 (part number of software: 6870309): The pump is switched off in order to avoid an overload. This safety status is not ended by the flow controller and returned to normal operation until a restart occurs (disconnection of supply voltage to the module), unless the load or pump supply power is still too great.

The same error symptoms occur if the return hose at the module is buckled.

Water Trap Module

Error log: 3517 (zeroing failed; no vacuum at the cuvette)
Julian: "Water Trap" alarm

For devices which were delivered through December 1996, a circuit error/component assembly error also exists in the water trap module of the Processor PCB (part number 8350301-03), which can lead to shut-down of the pump. The water trap light barrier for these devices not only reacts to attainment of the maximum allowable water level, but also switches off when touching the water trap prism with dry fingers, or if a water droplet remains on the prism (minimal error threshold). This results in the message "Water Trap?!" on the monitor and shut-down of the pump. The pump is not cleared by IRIA until the condition "water trap empty" has been restored.

Repair Procedure

Service Equipment

No.	Designation	Part No.
1	Extender board 96-2	7901631
2	Measuring probe, red, pp 130	7901024
3	Measuring probe, black, pp 130	7901025
4	Measuring lead, red, 0.25 m	7900679
5	Measuring lead lead, black, 0.25 m	7900680
6	Digital multimeter, 3-digit	7901021

- Switch off Julian.
- Unscrew rear panel of electronics module.
- Unscrew cover of board slot located to the left of CIO PCB.
- Plug extender board 96-2 into board slot located to the left of CIO PCB.
- Measure voltage between X14/4AC (12 VGND) and X14/5AC (+12 V) at X14 (bottom plug).
- Remove extender board 96-2 from board slot.
- Mount cover onto board slot.
- Remove fastening screws from IRIA.
- Remove IRIA from electronics module.
- Check software version on Flow PCB (part number 8350291, top vertical board). The ROM chip is located at upper left on component side and is identified with a label (software part number and version).
- Assemble Julian using the reverse order. Tighten 2.5 mm screws carefully!

Troubleshooting

Supply Voltage

- If +12 V supply voltage is not within admissible range (see "Power Supply to IRIA"), replace DC/DC converter.

Flow Controller PCB Software

- If version of installed Flow PCB software is 01.01 (part number 6870309), replace software with Flow PCB software version 01.02 (part number 6870441) by replacing Flow PCB (part no. 8350291-04) with a new one (repair/exchange parts are kept in stock for this purpose).

The new software version averages the pump supply voltage measurement values over a longer period of time. Voltage peaks are thus filtered out, and shut-down of the pump due to brief interference is avoided.

Make sure the return hose is not buckled or pinched.

Water Trap Module

If the water trap light barrier reacts too sensitively (see "Water Trap Module" on page 173 error cause), the IRIA Processor PCB (part no. 8350301) must be replaced. A modified filling level hybrid is mounted on Processor PCBs manufactured as of December 1996. This hybrid only reacts when the maximum permissible filling level of the water trap is reached, irrespective of light-barrier quality variations.

Final tests

- Perform safety tests according to Julian Test Certificate.
- Connect Julian to pipeline system and AC outlet.
- Switch on Julian and confirm initialization of self test.
- As soon as Julian is in stand-by mode, switch to MAN/SPONT mode.
- Disconnect sampling hose from Y-piece and breath into connector of the sampling hose.

After a few seconds, the CO_2 display should indicate an increased CO_2 value.

- Reconnect the sampling hose.

Displayed CO_2 value should decrease to 0% CO_2.

35.10.2 Display Error with Desflurane Measurement up to Software 1.04

Affects all units up to and including software version 1.04.

Description of error:

– The display format for Desflurane on the standard page of the screen is limited to two digits (x.x). This is why an inspiratory or expiratory Desflurane concentration of < 9.9 vol.% is not displayed. The measured value field is blanked out as soon as the Desflurane concentration exceeds 9.9 vol.%.

Safety hazard:

– There is no safety hazard for the patient because no wrong measured values is indicated on the screen. The actual measured value in the correct format is displayed on the data page. If an alarm occurs (for example, the upper Desflurane concentration limit is exceeded), the current measured value is displayed correctly on the standard page and an alarm is activated.

Remedy:

– As of software version 2.02, the values are displayed in a three-digit format (xx.x) on the standard page.

36 Processor PCB

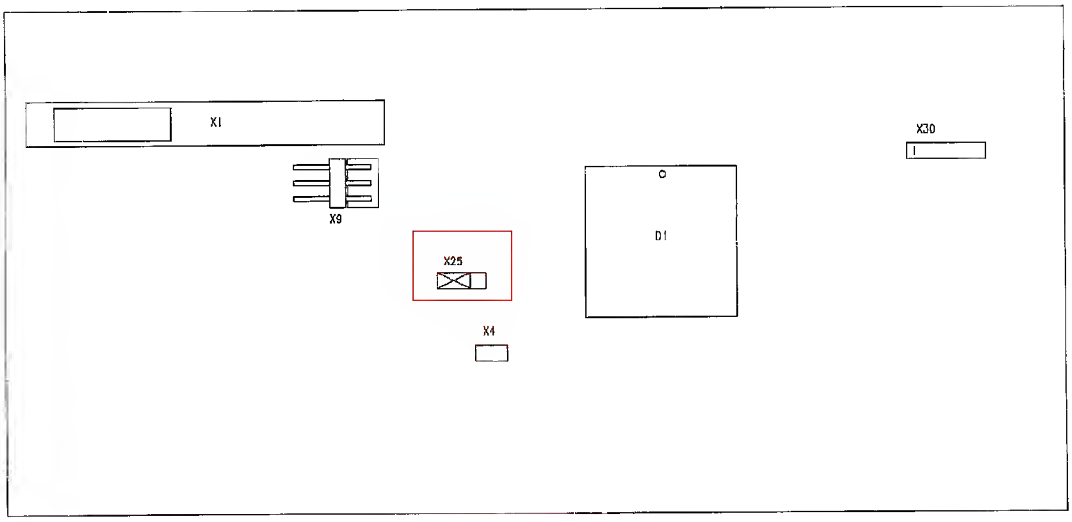


Fig.106: Processor PCB assembly, jumper position X25 with new water trap

• Pay attention to position of jumper X25 when mounting the new water trap.

37 AGAS Adapter PCB

Electrostatic discharge may damage electrostatic sensitive devices. **Always use a static-dissipative mat and a wrist strap** when handling electrostatic sensitive devices.

37.1 AGAS Adapter PCB Power Supply

X1	
Pin	Assignment
8c, 9ac, 10a	+12 V
10c, 11ac, 12a	12VGND
16a	+5 V
6a, 15a	DGND

37.2 AGAS Adapter PCB Pin Assignment

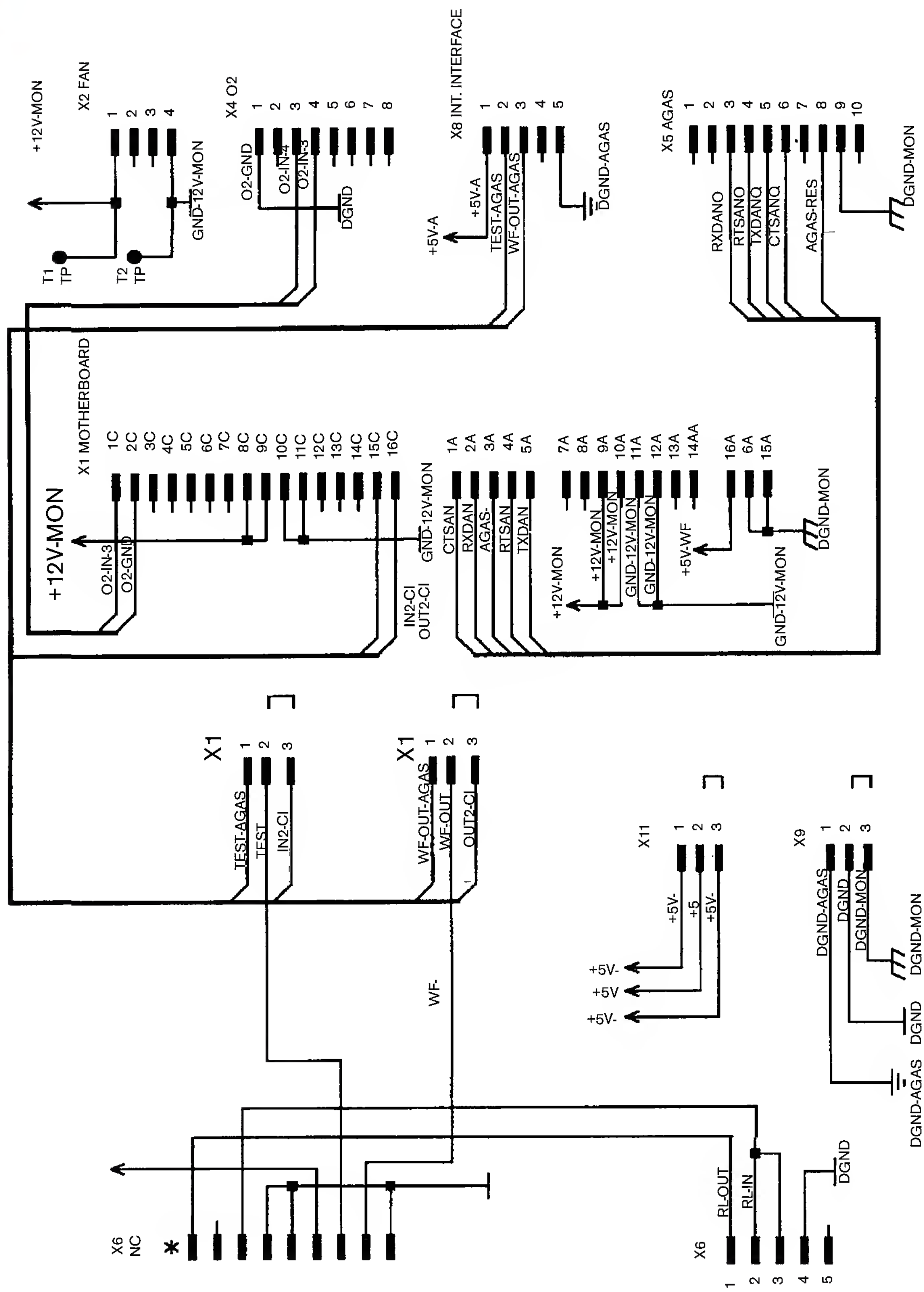


Fig.107: AGAS Adapter PCB pin assignment

37.3 AGAS Adapter PCB Component Diagram

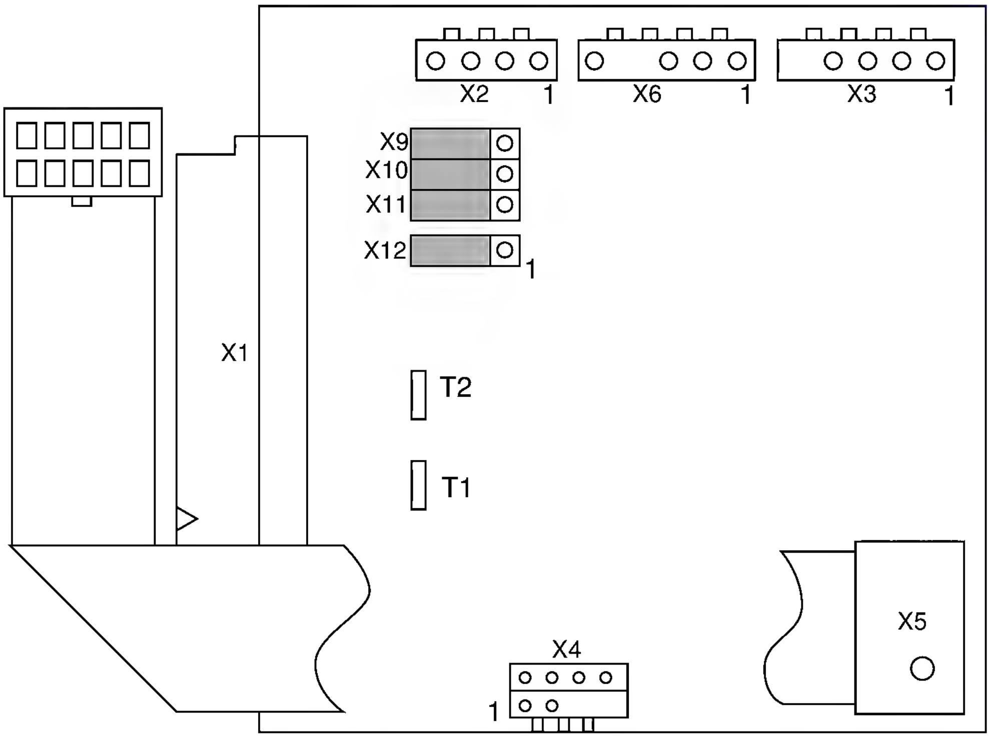


Fig. 108: AGAS Adapter PCB component diagram

37.4 Replacing the AGAS Adapter PCB

- Switch off Julian.
- Remove IRIA.
- Remove the AGAS Adapter PCB from IRIA (see also "Fig. 105: IRIA hardware components").
- Mount the new AGAS Adapter PCB.
- Mount IRIA into Julian.
- Assemble Julian ready for use.
- Check Julian according to Test Certificate.

38 Julian Software Download

Contents

38.1 Download Precautions

Caution:

Risk of damage to Julian's downloader in the event of power failure. Julian's battery capacity is not sufficient for the duration of the download procedure.

During the download procedure, Julian must be powered from an AC outlet.

Caution:

Risk of damage to Julian's downloader, if the power saving function is activated on your service laptop computer.

Before downloading, connect your service laptop computer to an AC outlet. Configure the power saving function (for AC outlet operation) such that neither the hard disk nor the display is switched off automatically.

Caution:

Risk of damage to Julian's downloader if background programs are activated.

Before downloading, deactivate all screensavers, virus scanners, or indexing functions (e.g. from Microsoft).

Read the "Questions/Answers" section under the service software "Help".

Caution:

Electrostatic discharge can damage electrostatic sensitive components. Use a static-dissipative mat and a wrist strap when handling electrostatic sensitive components.

38.2 Service Equipment

Test cable RS232 extension Service (9-pin sub D female connector on 9-pin sub D male connector, length = 3 meters, with service coding)	79 01 808

Service personal computer (or service laptop computer)

Doris-CD with service software, from version ≥ 9.3 with download version ≥ 4.0

Julian downloadable system software
(with current software version)

The following service equipment is also required in order to be able to download from the Ventdos Controller PCB:

RS232 converter	79 00 790

The current Julian software version X.XX for internal download comes with the software conversion kit.

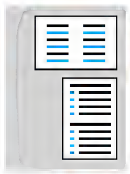
38.3 Typographic Conventions

Typographic conventions used in the description of this download procedure:

"XX.X..." = stands for the respective version number.

For example "ENTER" = key on the service computer.

"Service" = text on the display or text to be entered with the service computer.



38.4 Saving Customer's Configuration

Downloading a new software will overwrite all currently set customer parameters. Before downloading, read out the following customer parameters.

- Service mode

Service 2 Menu	Password
	Passwd sequence
	Min. alarm tone
	A-cone
	Operating hours
	O_2 emergency supply
	Bellows detection
	Battery detection
	Silence alarm tone
Flow Menu	Flow correction factor
Vent/EDOS menu	Max. flow PCV

- Standby/Configuration

Anesth. gas menu	auto/man
Default value menu	pulse tone
	Alarm tone
	Scaling
	Measurement parameters
	Log
	Interfaces
	Alarm limits
	Curves
	Basic configuration
	IPPV setting
	PCB setting
	Fresh-gas setting

38.5 Julian Software Download Procedure

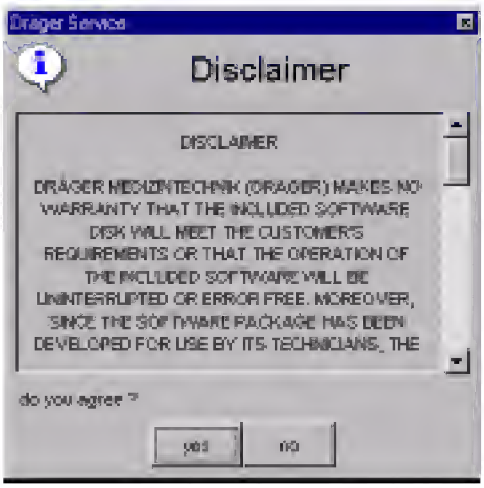
Caution:

Before downloading, read and understand chapter 38.1 "Download Precautions".

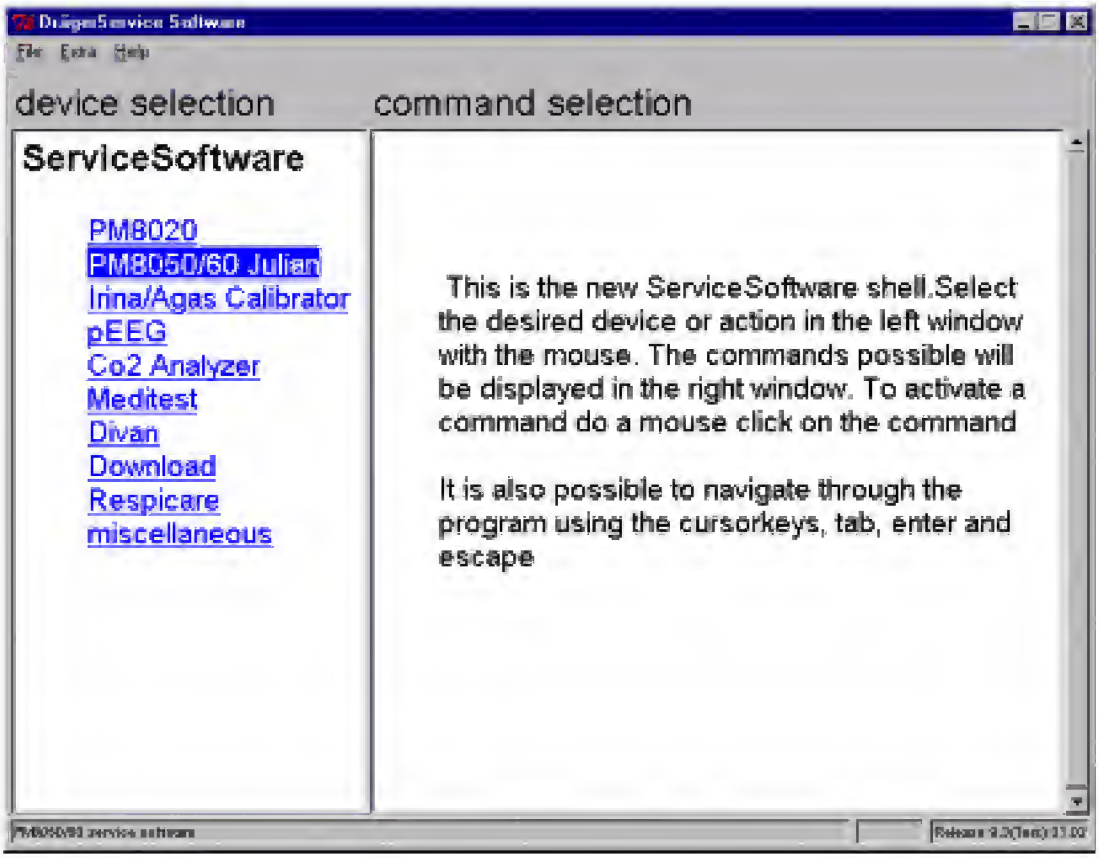
Julian and service computer are switched off.

Procedure:

- Connect Julian and service computer to AC outlets.
- Interconnect Julian and service computer using the RS232 extension. The interface on Julian is the CIO/COM2 PCB.
- Switch on the service computer.
- Activate the service software icon.
- Confirm the disclaimer information.



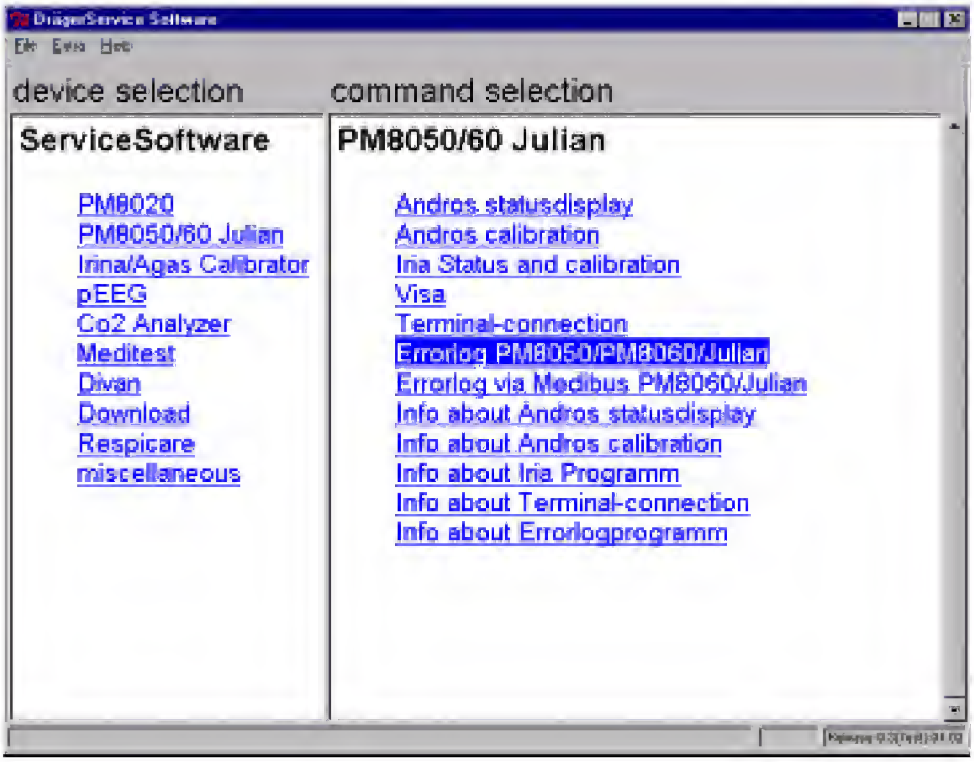
- Select "Download" from the device selection list.



- If the desired software version (the first disk of the Julian software) is not installed on the service computer yet, insert the disk with the Julian software in the disk drive of the service computer and select "Install new device software" from the command selection list.

The download software (COM2 interface) will be installed on the hard disk of your service computer. You will find the software in a directory with the device name and the version number. Please note that no software for repair download will be installed (the second disk of the Julian software).

- Select the desired software version "Julian Ver. XX.XX" from the command selection list.



- Switch on Julian.
- After confirming the check list, immediately start service mode.
- Wait until log has been fully configured (no flickering).
- Select the "SpO_2/VentEDOS" menu.
- Press the "PC Service Mode" key once. The following message will appear on laptop computer: **"Connect PC." Then press the main switch.**
- Wait approx. 5 s.
- Switch off Julian.
- Exit all applications on the service computer and confirm exiting by pressing "ENTER" or by clicking on the "OK" button.

The service computer now tries to establish a connection to Julian through the RS232 interface.

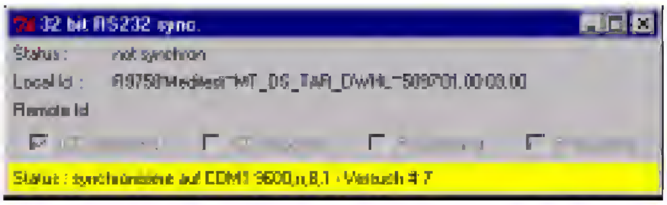
Note:

Should the connection be interrupted while transferring the master or supervisor processor files, the service computer will try to re-establish the connection 10 times. Should this fail, switch off Julian and restart the download procedure.

If a restart is not possible, then downloading from the RS232 interface of the Ventdos-Controller PCB is required for software versions < 1.04. This procedure is described under chapter 38.7 "Downloading Software for Ventdos-Controller PCB via Debug Interface". The procedure for software version 1.04 or higher is described under chapter 38.5.2 "Help in Case of Download Problems with Software 1.04 or Later".

If 32-bit synchronization is activated in the menu line under "Extras", then the following message will appear:

.



Note:

The ventilator's audible alarm may sound while downloading. If this happens, do not interrupt the download procedure and do not switch off Julian.

- Switch on Julian.
- Confirm the disclaimer information.

The following message will appear on your service computer as soon as synchronization is completed: "Connected with ..."

- Using the Page↑ (PGUP) or Page↓ (PGDW) keys, select the "downloadrequest" command and confirm by pressing "ENTER".

- Confirm the software version by pressing "ENTER (CR)".

Software downloads can be carried out individually or all at once. Select by pressing the key ↑ or ↓ or the "SPACE" bar on the service computer. A download file has been selected if an "X" appears under "selected".

- Select the download files (normally all 3).
- Press "ENTER".

Download procedure starts. The service computer displays information about the download progress. The complete download procedure will take about 40 minutes.

The following message will appear as soon as the download procedure is completed:

- Switch off Julian.
- Remove the connection between the service computer and Julian.

38.5.1 Final Tests

- Switch on Julian and wait until check list appears. After acknowledging check list, start service mode.
- From service menu 2, select "Config. Reset". The screen is blanked, then wait until the check list appears.
- Switch off Julian and then on again.
- After confirming the check list, immediately start service mode.
- Set parameters written down before downloading. Calibrate the pressure sensor in the SPO_2/Pressure menu with open breathing system. Calibrate the flow sensor in the flow menu.
- Switch off Julian.
- Switch on Julian and wait until the self-test is completed.
- Set customer parameters in the "Standby/Configuration" menu.
- Connect test thorax and check ventilation function according to Julian Test Certificate, test item 23.2.

38.5.2 Help in Case of Download Problems with Software 1.04 or Later

Procedure in case of inadvertent abort of download through external RS232.

What can be done if master or supervisor processor downloading has been aborted inadvertently?

With software versions below 1.04, downloading again was only possible via the internal RS232 interface. To do so, the device had to be opened.

With software version 1.04 or higher, you can now repeat the download procedure via the external RS232 interface if VentDos Controller MA or SV downloading was aborted due to an interruption of data transfer. Proceed as follows:

- Switch off Julian.
- Make sure the connection between the service computer and Julian is OK.
- Carry out the service computer procedure until you are prompted to exit all other applications. Confirm the prompt (see download description).
- Wait approximately 5 s and then switch on Julian.
- Wait until Julian reaches the check list.

The next 5 steps must be carried out within 10 s.

If the error log has too many entries, the 10-s requirement cannot be met. In this case, you need to carry out a "Config. Reset" first. "Config. Reset" deletes all error log entries.

- Confirm the check list and enter service mode.
- Allow the error log list to build up (no flickering visible).
- Select SpO2/VentEDos.
- Activate the computer service mode.
- Switch off Julian.
- Wait 5 s and then switch on Julian.

The laptop displays "Remote to 8055 'Julian' " 1.04.

- Restart the download procedure on the service computer and download the master or supervisor software.

38.6 Downloading Software for CIO PCB via BD32

Downloading software via BD32 is only necessary if the initial program loaders on the boards were destroyed by a power failure while downloading the software.

38.6.1 Service Equipment

Service computer	
Download software program BD32	
Debug adapter	79 01 980

38.6.2 Installing Download Programs

Switch on the service computer.

Insert disk in drive A.

Enter: "a:install"<ENTER>

This will automatically install the program on your service computer.

Enter: "C:\bd32\bd32"<ENTER>

The BD32 program is started.

38.6.3 Downloading Software to the CIO PCB

Caution:

Electrostatic discharge can damage electrostatic sensitive components. Use a static-dissipative mat and a wrist strap when handling electrostatic sensitive components.

The following steps can only be carried out if the initial program loader on the CIO PCB has not been destroyed.

- Switch on Julian and start service mode after the check list is completed.
- Write down settings in service mode menus "Service2" and "Flow".
- Switch Julian off and on again. After confirming the check list, quit the self test.
- Write down the customer configuration shown in the configuration menu.
- Switch off Julian.
- Connect debug adapter to the service computer (parallel port) and to the debug connector (X6) on the CIO PCB (pin 1 to pin 1, two pins remain free).

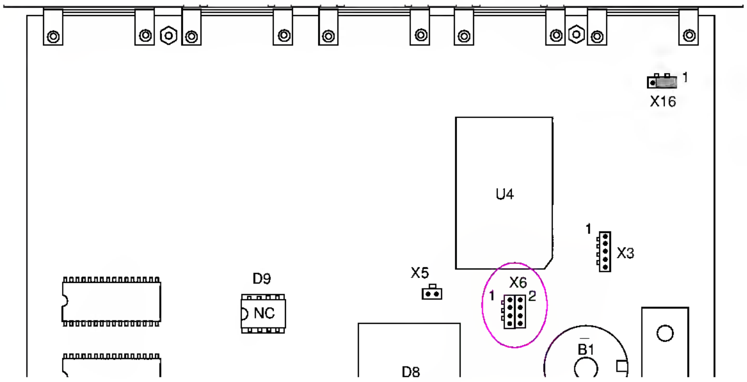


Fig.109: Debug connector on CIO PCB

- If problems occur with communication between the BD32 program and the processors on the Julian boards, then the interface delay value must be increased. This is done in the BD32 program by entering "Port LPT1 0 to 200" (for example, "Port LPT1 10" for 486 processor).

  Examples of delay values:
  386 processor = 0
  486 processor = 10
  Pentium processor = 200

- Switch on Julian and press the reset button on the sub D 25 connector of the debug adapter.

- Select the program to be downloaded: "do progvers.do" < Press "ENTER">

If the "Continue Y/N" prompt appears, enter "Y" and confirm. If the "Continue Y/N" prompt appears again, enter "Y" again (after repeating this procedure several times, the service computer will abort the program. Restart the program by entering "do progvers.do").

Data transfer is complete after approximately 7 to 30 minutes.

Download was successfully completed if the service computer displays "ROM check ok". The displayed error code can be neglected.

- Confirm the "Continue do Y/N" prompt with "Y".
- If download was not completed successfully, enter again: "do progvers.do" and repeat the download procedure.
- If download was successfully completed, enter "exit" to exit the program.
- Switch off Julian.
- Remove the debug adapter.
- Reassemble Julian ready for operation.

- Perform safety tests according to Julian Test Certificate and allow Julian to complete self test.
- Perform the final test under chapter 38.5.1 "Final Tests" .

38.7 Downloading Software for Ventdos-Controller PCB via Debug Interface

Downloading software via the debug interface is only required if the initial program loaders on the boards were destroyed by a power failure while downloading the software. After downloading always copy the current device software using the service software's download program.

Caution:

Electrostatic discharge can damage electrostatic sensitive components. Use a static-dissipative mat and a wrist strap when handling electrostatic sensitive components.

38.7.1 Service Equipment

Service computer	
RS232 extension	79 01 808
RS232 converter	79 00 790
Julian "Download repair" software (second disk)	79 10 479

Julian "Download repair" software can be found on the latest Julian software disk.

38.7.2 Installing the Software

Insert the Julian "Download repair" software disk in drive A and enter "A:\install". Follow menu prompts on service computer. A directory named "Flash" will be created on the hard disk and the software will be copied to this directory. Approx. 1 MB space is required on the hard disk.

38.7.3 Downloading Software to the Ventdos-Controller PCB

- Switch on the service computer.
- Switch off Julian.
- Slide the pneumatics module to the rear.

- If the buzzer sounds, you can deactivate it with the buzzer jumper.
- Interconnect Julian and the service computer using the RS232 extension and the RS232 converter. Connect the RS232 converter to the supervisor interface.
- Check the jumper positions of X12 and X26. The jumpers should be positioned as shown in the following Figure.

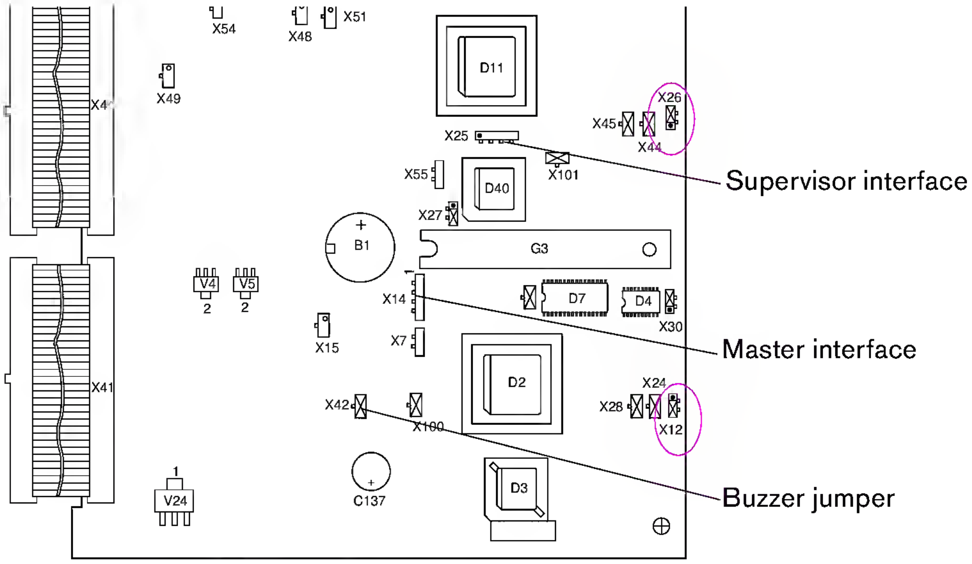


Fig.110: Ventdos Controller PCB download configuration

Start the download program as follows:

- Enter "cd Flash" to change to the "Flash" directory.
- To start the program, enter "dl_pc.exe" and confirm.
- Enter the file name "sv_XXX" (XXX stands for respective software version) and confirm.
- Enter the name of the COM port connected to the service computer (COM1 or COM2).
- If a new initial program loader is downloaded, a prompt will appear asking for a password. The password is "MAGIC".
- Switch on Julian.

Download will be carried out automatically. Completion of download will be indicated by a bleep sound from the service computer (the program can be aborted any time by pressing "ESC" and then restarted as described above).

If the download procedure does not start with the supervisor, try again using the program "dl_pc1.exe". In software version 1.04 or higher, this program can also be found in the "Flash" directory. This program uses a higher baud rate for data transfer.

- Switch off Julian.

- Connect the service computer to the master interface.
- Proceed as with the download for the supervisor, but enter "ma_XXX" instead of "sv_XXX".
- Reassemble Julian ready for operation. If you have removed the buzzer jumper, replace it in its original position.
- Perform safety tests according to Julian Test Certificate and allow Julian to complete self test.
- Perform the final test under chapter 38.5.1 "Final Tests" .

39 Julian Service Mode

Contents

40 Accessing the Service Mode

Accessing the Service Mode while in the standby mode:

Julian is switched ON.

- Press softkeys 5 and 6, and “nextpage” key simultaneously (this Service Mode will not allow you to access “Ventilator test” and “EDOS test” pages).

Accessing the Extended Service Mode (including "Ventilator test" and "EDOS test")

- Switch Julian ON.
- Wait until check list appears.
- Acknowledge check list and, after completion of "test step 16", press softkeys 5 and 6, and “nextpage” key simultaneously. You can exit this Service Mode only by switching Julian OFF.

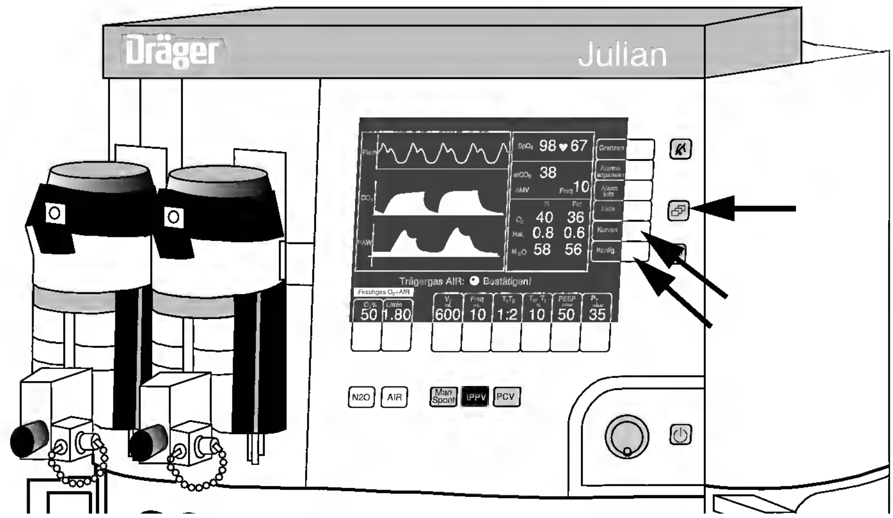
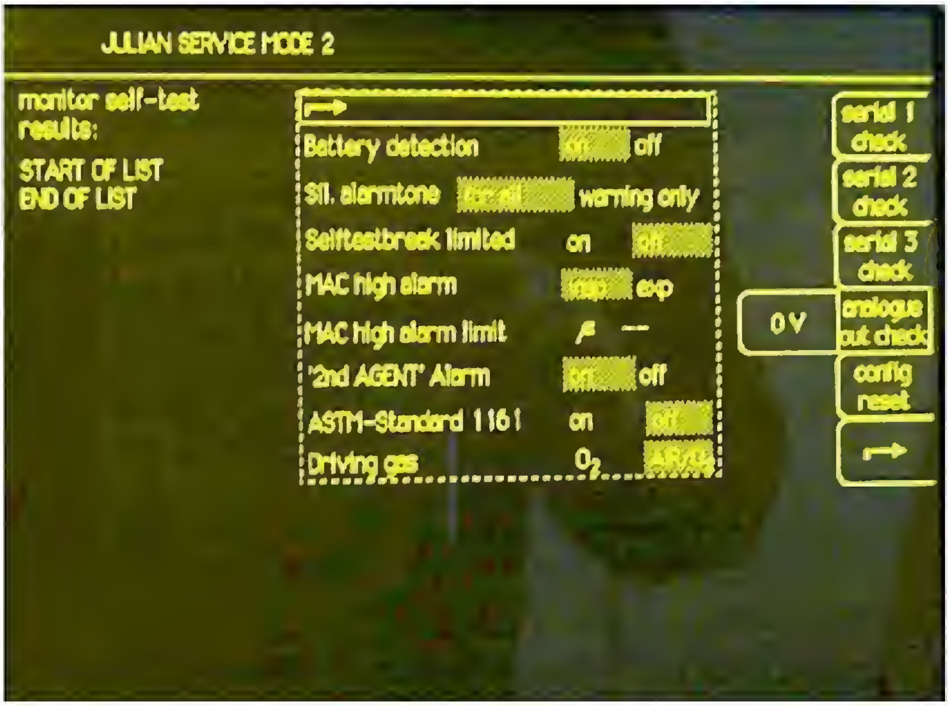


Fig.111: Location of Service Mode access keys

41 Changes in Service Mode of Software Version 3.0

The following changes apply to Service Mode of software version 3.0:

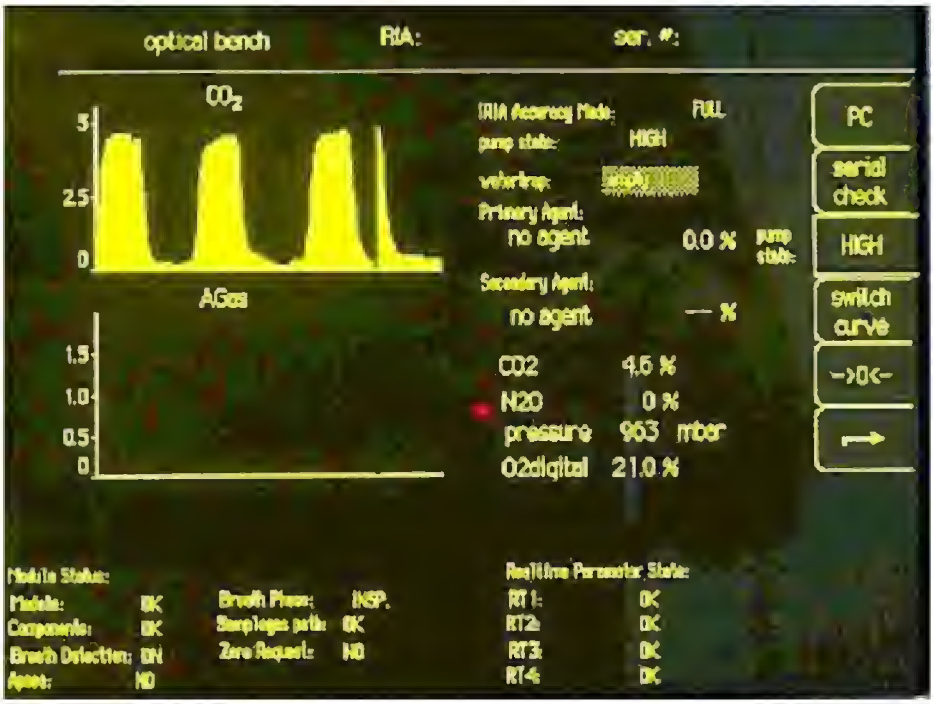
The following additional settings are possible on the Julian Service Mode 2 screen "config/more":



Self-test results:	Error message during power-on self-test.
Battery detection	As before.
Sil. Alarmton	As before.
Selftestbreak limited	on/off If "off" is selected, the user can abort the self-test as many times as she or he likes. Otherwise the self-test can be aborted only 10 times in sequence.
MAC high alarm	insp/exp The upper MAC alarm is triggered when the inspiratory or expiratory limit is exceeded.
MAC high alarm limit	Adjustable

'2nd AGENT' Alarm	on/off To comply with ASTM standard (USA) an alarm message is generated with activated alarm function as soon as a defined MAC limit of the secondary gas is exceeded. This limit is approximately 0.1 MAC. However, the limit is recalculated in the course of an operation (hysteresis, memory behavior).
ASTM-Standard 1161	on/off If this US standard function is switched on, more detailed CO_2 alarm symbols are displayed. Deactivated alarms, for example, are shown with a crossed-out bell symbol. Observe local regulations when this function is switched off.
Driving gas	O_2 + AIR/O_2 If O_2 is used as the only driving gas, no error message related to test 8 will appear in position "O_2" during the self-test.
Planned (but not represented yet)	In future, the setting at the bottom of the list will allow the user to reverse the order of the vertical flowmeter tubes (O2 + N2O/AIR or N2O/AIR +O2).

The screen of the optical bench (IRIA) contains additional parameters (see bottom left corner on the following Figure):

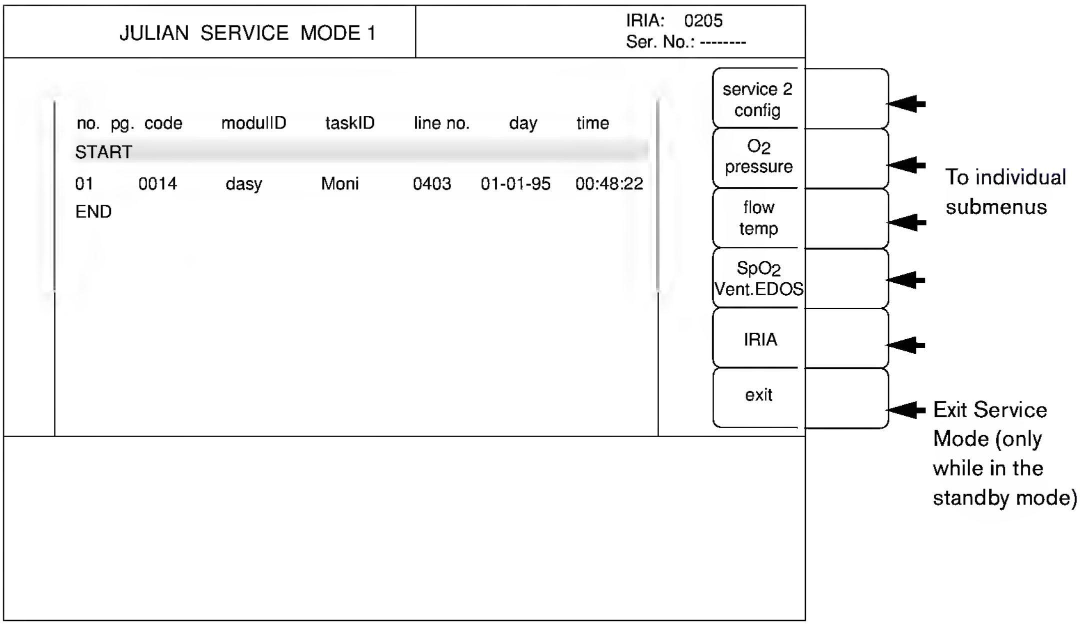


For troubleshooting purposes, the module or component status messages can be interpreted as follows:

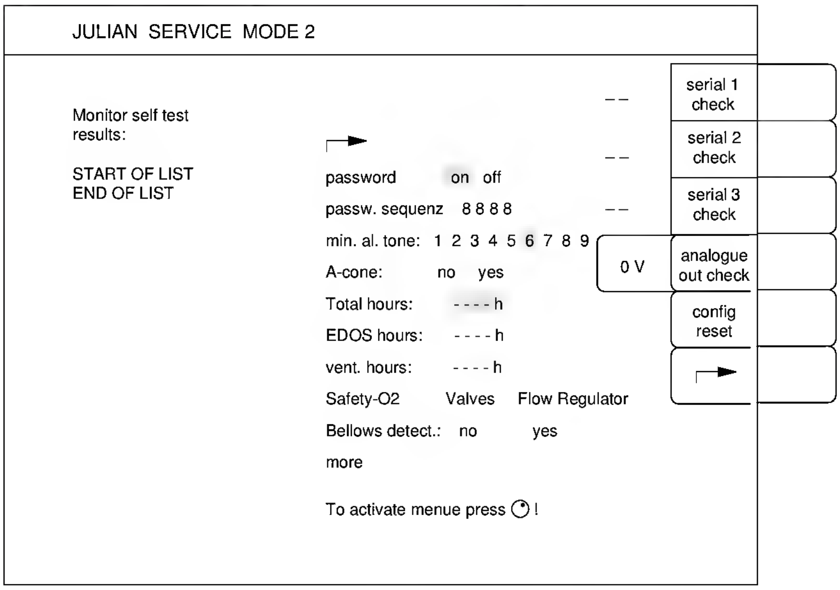
Self-test results	Error messages during the power-on self-test.
Module:	NOK Possible causes: – The operating voltage of Iria is off tolerance – RAM error – Pressure test during zeroing failed.
Components:	NOK Possible causes: – Sensor head – Pump – Water trap

42 Service Mode for Software Version 2.n

42.1 Service Mode 1

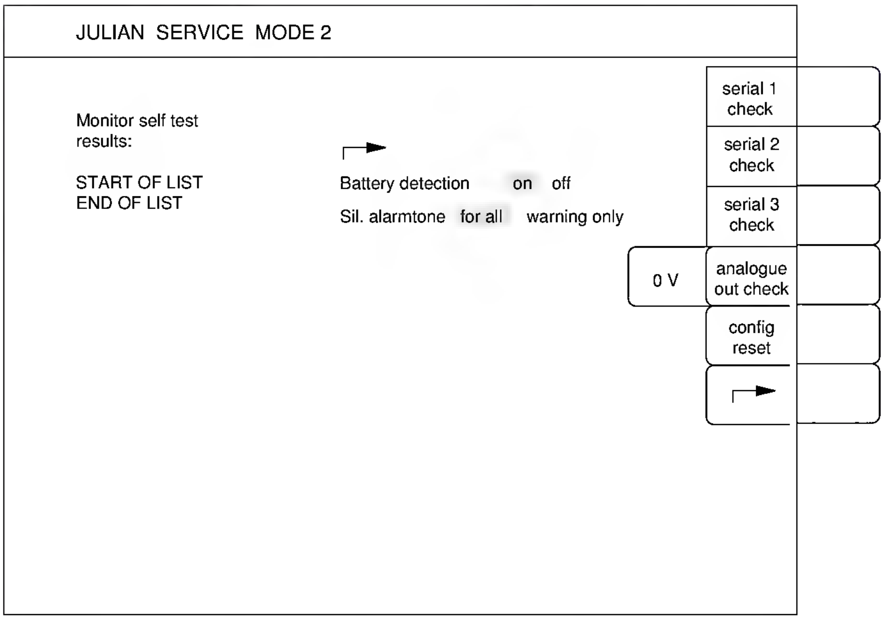


42.2 Service Mode 2



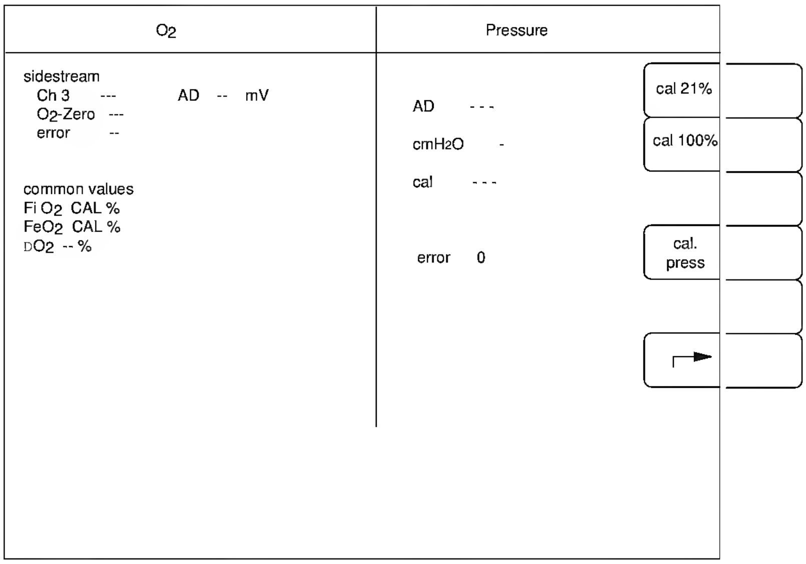
Self-test results	Error messages during power-on self test
Total hours	Total operating hours of Julian (including standby). Operating hours can be adjusted (for example, after replacing battery on CIO PCB). Operating hours will only be displayed if the Service Mode has been selected after power-on.
EDOS hours	EDOS operating hours (MAN/SPONT). Operating hours will only be displayed if Service Mode has been selected after power-on.
vent. hours	Ventilator operating hours (IPPV/PCV). Operating hours will only be displayed if Service Mode has been selected after power-on.
serial 1,2,3 check	Check of serial “RS 232” interfaces located on rear panel. For each test it is necessary to short-circuit pins 2 and 3.
analogue out check	Check of analog interfaces. Preset voltage is available at outputs.
config reset	If you carry out a "config reset", the whole RAM contents will be deleted. This includes log, time, date, customer settings, all calibration values, and pressure sensor calibration value.
Safety-O2	With valves: Safety flow via V27 and V28. With manual O2 flow control: depends on Julian’s hardware status.
Bellows detect.	"yes" means the fresh-gas shortage conversion kit is fitted.
more	Opens submenu for "Battery detection" and " Sil. alarmtone" parameters.
→	Pressing this softkey returns to first Service Mode page (applies to all Service Mode pages).

42.2.1 Submenu "more"

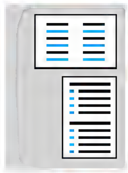


Self-test results	Error messages during power-on self test
Battery detection	For all power supply units up to version number "Ver04" set to "off". For power supply units 8601765-00 or later with version number "Ver05": set to "on".
Sil. alarmtone	For all- all "warning", "caution", and "advisory" messages get through although silenced. Warning only: - only new warnings get through.

42.3 FiO_2/Pressure

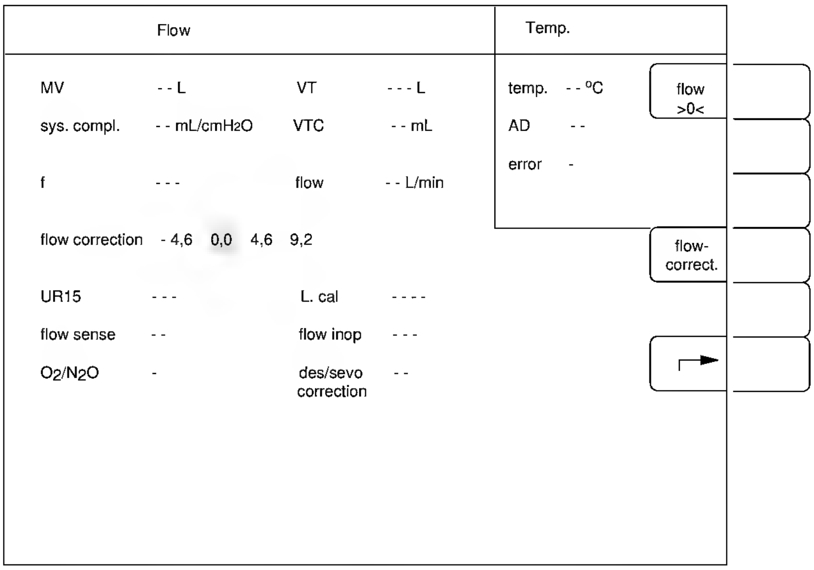


CH 3	Displays sensor voltage of O_2 sidestream measurement. 21% O_2 correspond to 10–21 mV, and 100% O_2 correspond to 48–91 mV.
O2-Zero	Measured offset value on Measured Value PCB. Under normal conditions, it is between 150 and 250.
O2 error	1 Unstable offset voltage 2 Unstable calibration value 3 Calibration constant is off range 4 Calibration data stored in the TKRAM is invalid 5 Sensor voltage is too low 6 Sensor voltage is too high 7 No sensor available 8 Plausibility error in connection with agent analyzer 9 Calibration interrupted (leak test or similar) 10 Zero switch is defective 11 Anesthetic gas error 12 No O_2 measurement (condensation on O_2 diaphragm or similar)
FiO2 FeO2 DO2	Displayed values correspond to current O_2 concentration. “CAL” is displayed during calibration procedure, “INOP” is displayed if an error has occurred or if no sensor is connected.
AD	Decimal value of A/D converter channel.
cmH_2O/mbar	Measured pressure in mbar. Range: –?? cmH_2O to ?? cmH_2O. Measured pressure in mbar. Range: –10 mbar to 99 mbar.
cal	Calibration value of A/D converter channel.



cal error	Pressure measurement error code. 0 = no error. 1 = P > ??? cmH_2O, > 100 mbar 2 = P < ??? cmH_2O, < −10 mbar 4 = pressure during calibration is too high 5 = pressure during calibration is too low

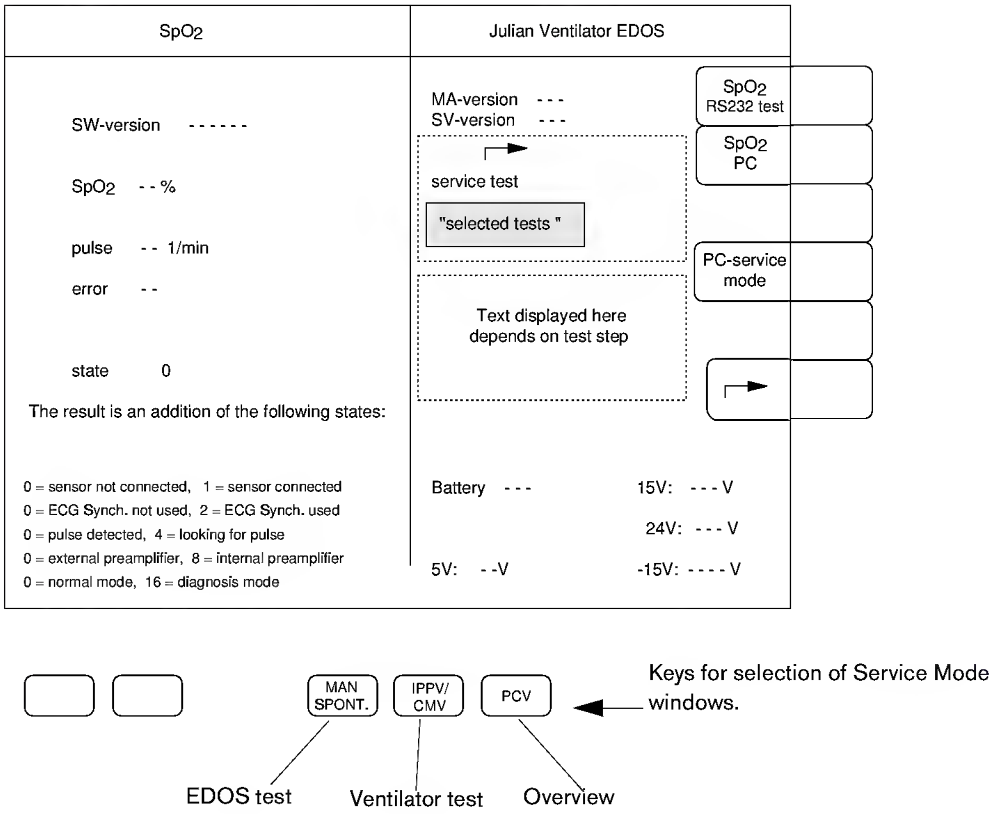
42.4 Flow/Temperature



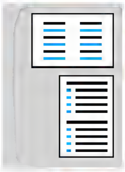
MV	Minute volume in L/min.
V_T	Tidal volume in mL.
Sys. compl.	System compliance value.
VTC	Currently not used in Julian.
f	Ventilation frequency in 1/min.
flow	Current flow value in L/min.
flow correction	This correction factor is used to compensate for deviations in flow measurement at higher altitudes. Factor is shown in %.
UR15	Voltage across 15 ohm resistor of flow measuring bridge. After calibration, this value should be between 1005 mV and 1015 mV.
flow sense	Value of ground line voltage of flow sensor. This voltage should be between −20 and +20.

flow inop	Voltage within flow measuring bridge at calibration converter of the flow module. After successful calibration, value should be between 38 and 518.
L. cal	Decimal value of calibration D/A converter of flow measurement bridge. Optimum value is between 500 and 2000. If value is not within this range, measurement of flow gives lower or higher results.
des/sevo correction	Factor for correction of desflurane or sevoflurane measurement.
O2/N2O	Display Gas type O_2/N_2O 16 100% 14 AIR 12 85% 10 76% 8 67% 6 57% 4 47% 2 36% 0 24%
temp.	Measured temperature in °C.
AD	Digital value of A/D-converter channel of temperature measurement. < 20°C INOP 20°C approx. 780 34°C approx. 490 40°C approx. 334
error	Temperature measurement error code. 0 = OK 1 = short-circuit 2 = interruption

42.5 SpO_2/Julian Ventilator EDOS



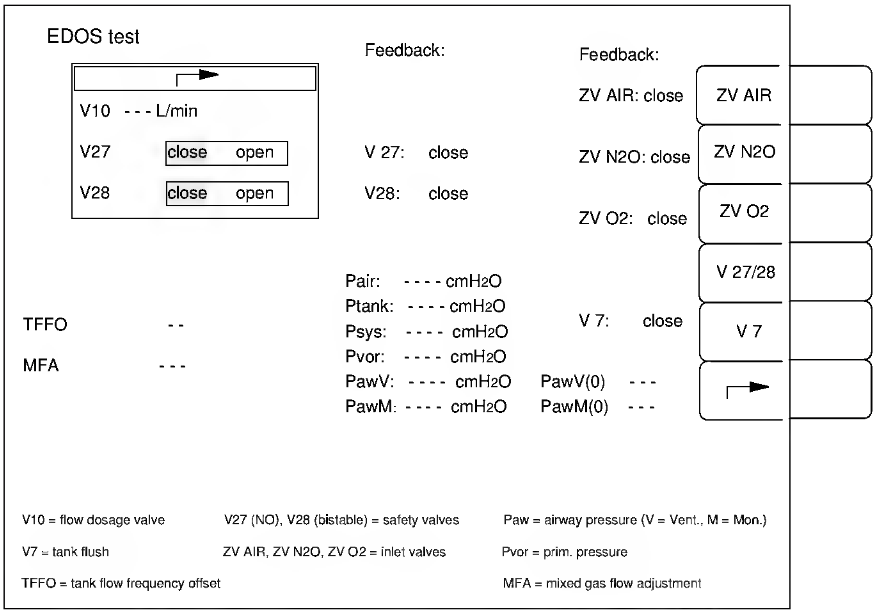
SW version	Software version. For example, “Minisoom V 1.0” means Minisoom PCB, version 1.0, from Nellcor.
SpO2	Measured value of SpO_2 saturation in %.
pulse	Pulse frequency in 1/min.
error	Error code of SpO_2 module. Code not specified yet.
state	Status message of SpO_2 module.
MA-version SV-version	Software version of supervisor and master on Ventdos Controller PCB.
service test	This function allows you to select individual power-on self tests using the rotary knob when selecting Service Mode after power-on.
Service test results	Display of power-on self test number and of error codes from master and supervisor.



Battery	A/D converter value of battery voltage. Normal: 103 to 956 (during battery operation). Equation: Voltage in V = $15 + \frac{\text{displayed value x 15}}{1024}$
5V, etc.	Display of pneumatics assembly operating voltages.
SpO2 RS 232 test	Test of RS 232 interface to SpO_2 PCB. It is necessary to jumper RXD and TXD.
SpO2 PC	Not used by DS.
PC-service mode	Download key. Press key. Switch off Julian. Switch on Julian. Carry out download (not available yet).

42.5.1 EDOS Test with Safety Flow Valves V27/V28

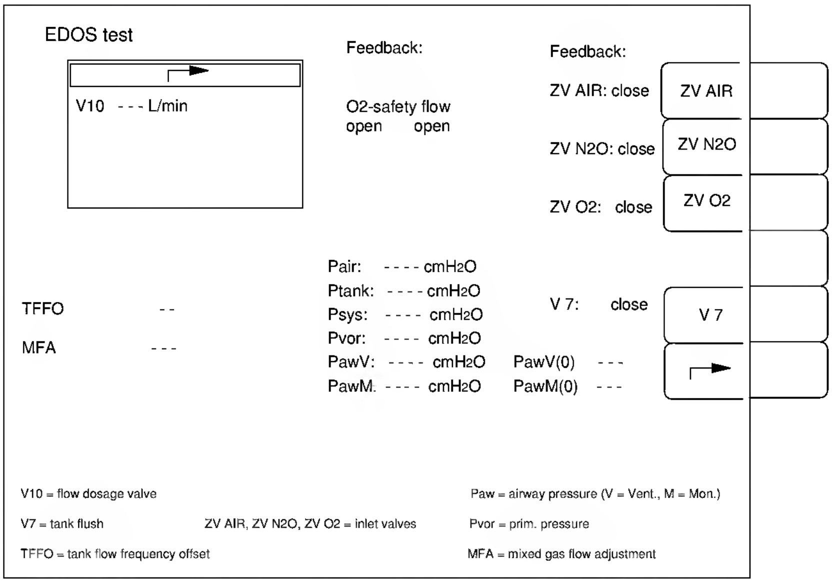
- Select test using the "MAN/SPONT" key.



V10	Display and adjustment of V10 (target value) in the range of 0 to 12 L/min.
V27, 28	Switching of valves V27 and V28 (can be set to static and switched individually).
TFFO	Display of container flow frequency offset. The measured value of the pressure sensor (ΔPmix) is converted into a frequency. The value is displays in steps of 10 ms. Target value: 10<value<100. The value is determined only during power-on test.
MFA	Display of mixer flow calibration value. This value is determined only during power-on test. Value is 0.XXX with XXX = display. Target value: 750<display<1000.
Pair, etc.	Pressure sensor values.
Feedback	Display of valve status (electrical).
ZV AIR key, etc.	Used to activate respective valve.
PawV (0) PawM (0)	Calibration value of airway-pressure sensor: PawV (0) 84 - 123 PawM (0) 150 - 250

42.5.2 EDOS Test with Manual O2 Flow Control Valve

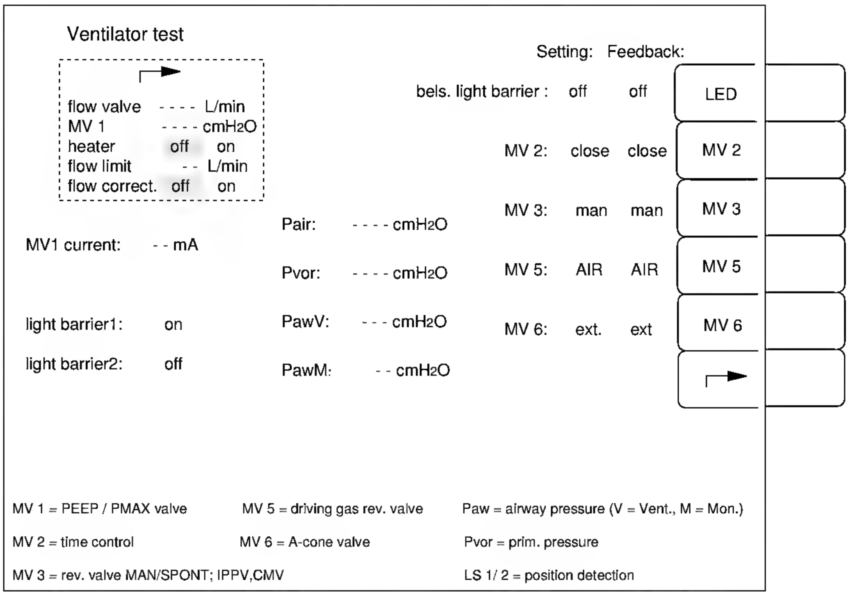
- Select test using the "MAN/SPONT" key.



V10	Display and adjustment of V10 (target value) in the range of 0 to 12 L/min.
O2-safety flow	Shows status of manual O2 flow control valve in the frontplate (instead of V27 and V28).
TFFO	Display of container flow frequency offset. The measured value of the pressure sensor is converted into a frequency. The value is displays in steps of 10 ms. Target value: 10<value<100. The value is determined only during power-on test.
MFA	Display of mixer flow calibration value. This value is determined only during power-on test. Value is 0.XXX with XXX = display. Target value: 750<display<1000.
Pair, etc.	Pressure sensor values.
Feedback	Display of valve status (electrical).
"ZV AIR" key, etc.	Used to activate respective valve.
PawV (0) PawM (0)	Calibration value of airway-pressure sensor: PawV (0) 84 - 123 PawM (0) 150 - 250

42.5.3 Ventilator Test

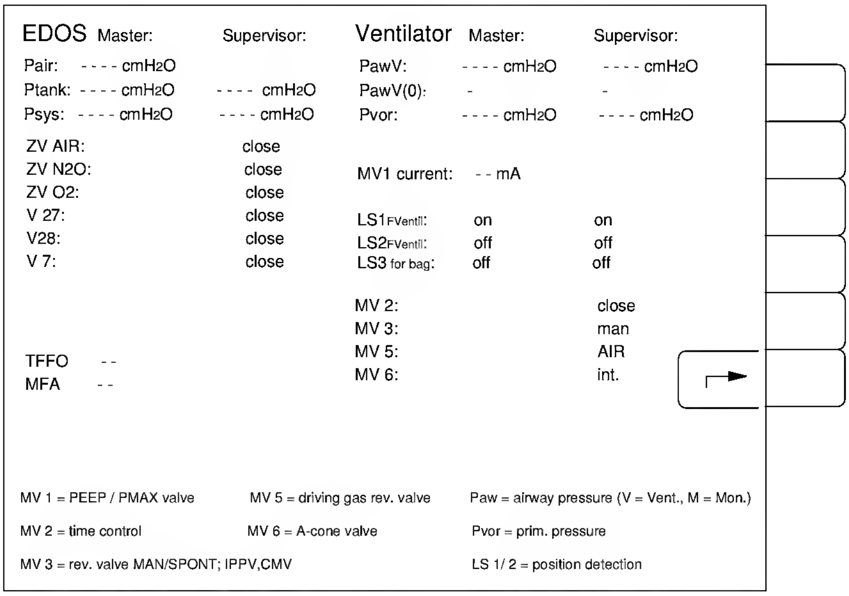
- Select test using the "IPPV" key.



flow valve	Display and adjustment of flow valve (1 to 75 L/min).
MV 1	Display and adjustment of MV1 (0 to 100 mbar).
heater	Switching heater on/off.
flow limit	Maximum flow limit in the PCV mode.
MV1 current	Display of MV1 control current (approx. 90 to 470 mA).
light barrier1	Light barrier 1 of flow valve.
light barrier2	Light barrier 2 of flow valve.
Pair, Pvor, etc.	Display of pressure sensor values (absolute pressure, Paw = airway pressure).
Setting / Feedback	Shows settings of MV2, MV3, MV5, and MV6 including feedback (electrical).
MV2, 3, 5, 6 keys	Used to activate respective valve.
LED	The fresh-gas shortage conversion kit must be fitted. Status of bellows light-barrier. This softkey is only visible if bellows detection option in service menu 2 is set to "yes". Display with active test: Setting: Feedback: Bellows in the light barrier: on off Bellows in the light barrier: on on

42.5.4 Overview of EDOS and Ventilator with Safety Flow Valves V27/V28

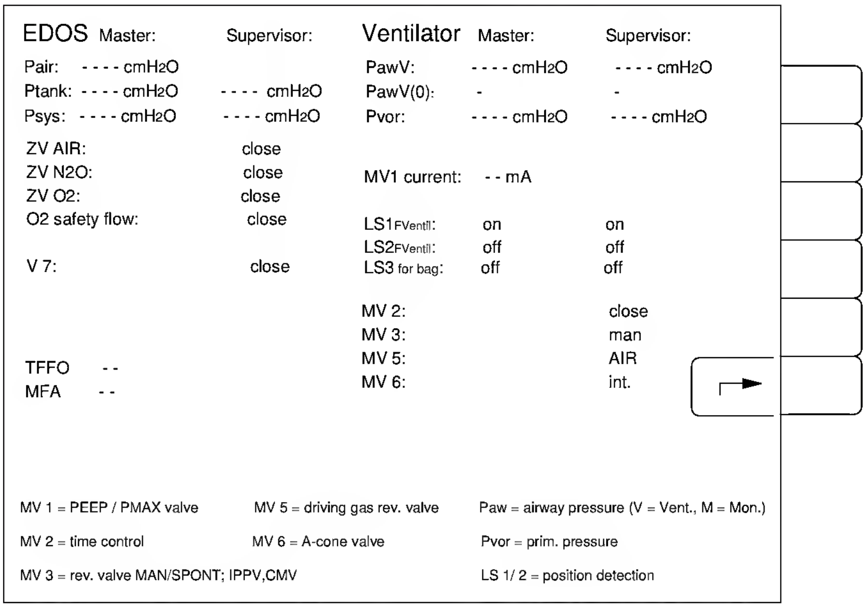
- Select test using the "PCV" key.



Master / Supervisor	Feedback from processors located on VentDos-Controller PCB.

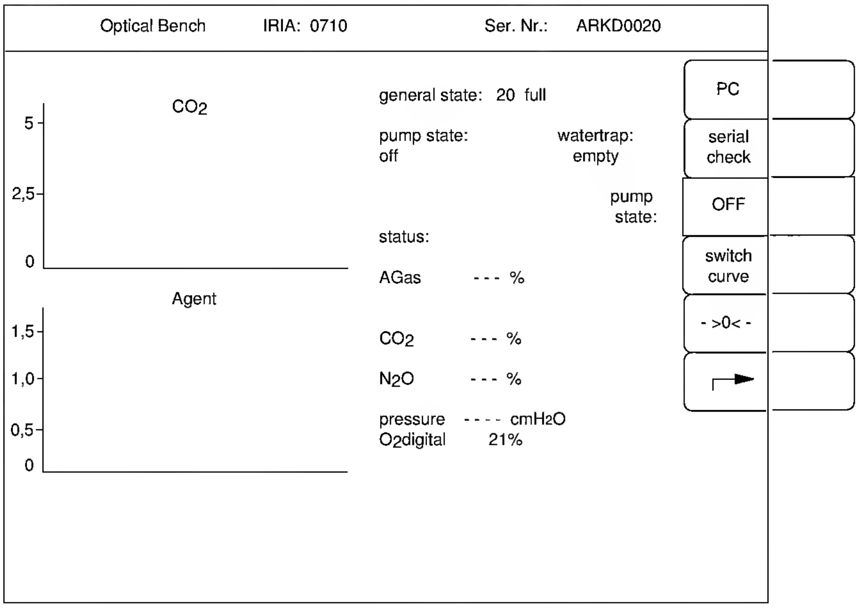
42.5.5 Overview of EDOS and Ventilator with Manual O2 Flow Control Valve

- Select test using the "PCV" key.

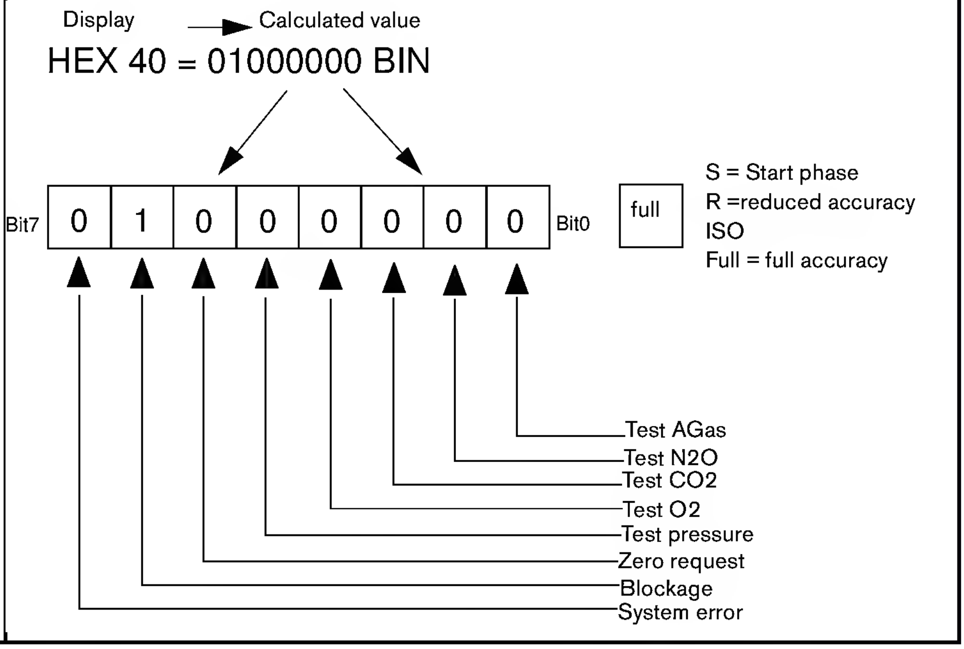


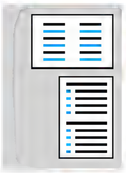
Master / Supervisor	Feedback from processors located on VentDos-Controller PCB.

42.6 Agent Analyzer (optical bench)



ser. #	Serial no. of agent analyzer. If serial no. is displayed, communication is OK.
general state	The agent analyzer status message is displayed as hexadecimal value (HEX). If for example "40" is displayed, convert the hex value into a binary value (BIN) first. Use the following matrix to allocate the respective status to the bit set to "1". In our example the status would be "blockage". If several (BIN) "1" occur, this may result in a combination of status messages.

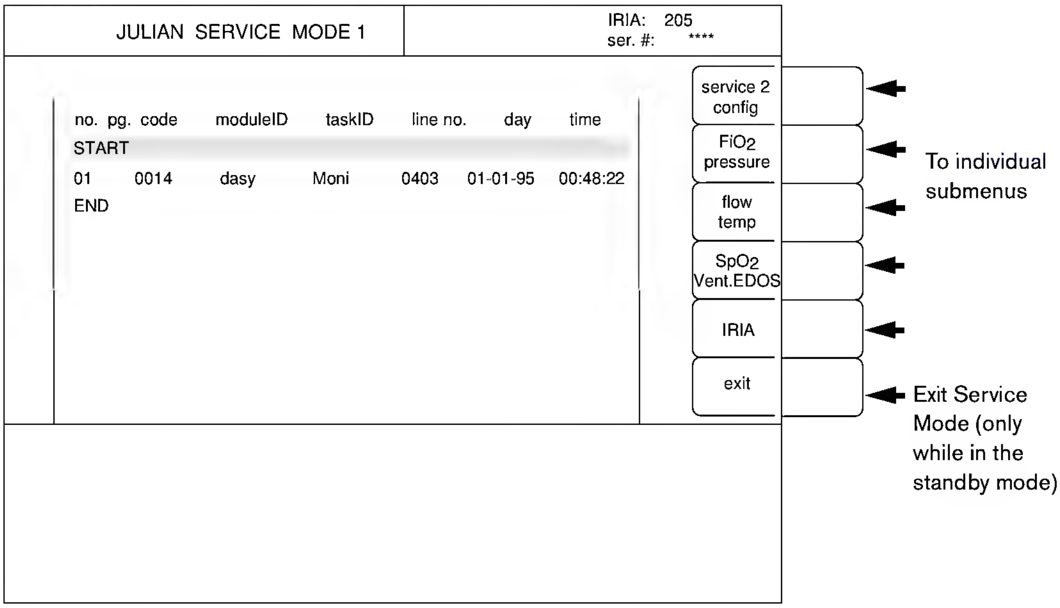




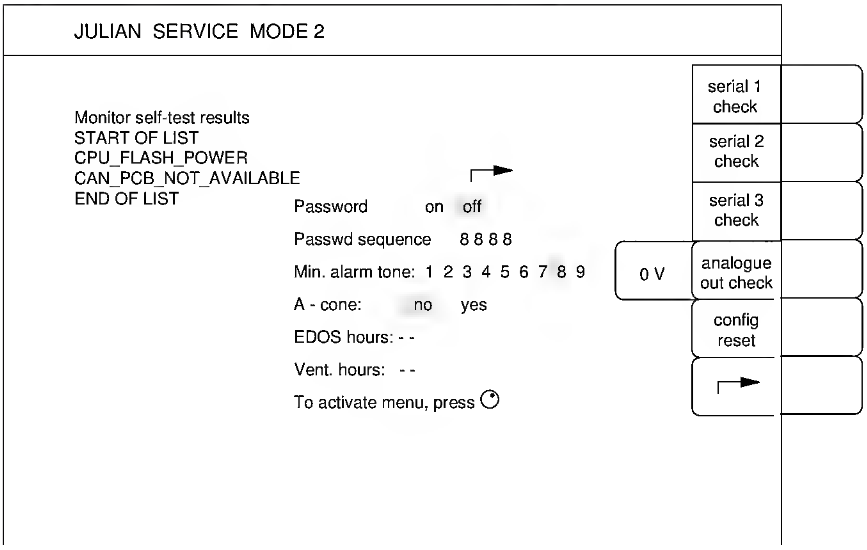
OFF	Pump flow setting: (OFF, low, high, PURGE) **During automatic calibration of sidestream O_2 cell, pump flow setting is deactivated**.
AGas	Anesthetic gas value from agent analyzer and display of type of anesthetic agent.
CO2	CO_2 value from agent analyzer.
N2O	N_2O value from agent analyzer.
pressure	Pressure value (absolute) in agent analyzer (cuvette pressure).
O_2digital	O_2 value used for compensation of measurement. This value can be adjusted by pressing rotary knob, turning rotary knob to calibration gas value, and pressing rotary knob again to confirm.
PC	Changeover of communication from IRIA/monitor to IRIA/PC. In PC mode, monitor screen is “frozen”.
serial check	For repairs: Serial interface to agent analyzer can be checked by disconnecting connecting cable to agent analyzer and by jumpering RXD and TXD.
switch curve	Toggles bottom curve between N_2O and anesthetic gas.
>0<	Triggers zeroing of agent analyzer.

43 Service Mode for Software Version 1.04 or earlier

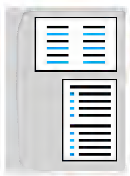
43.1 Service Mode 1



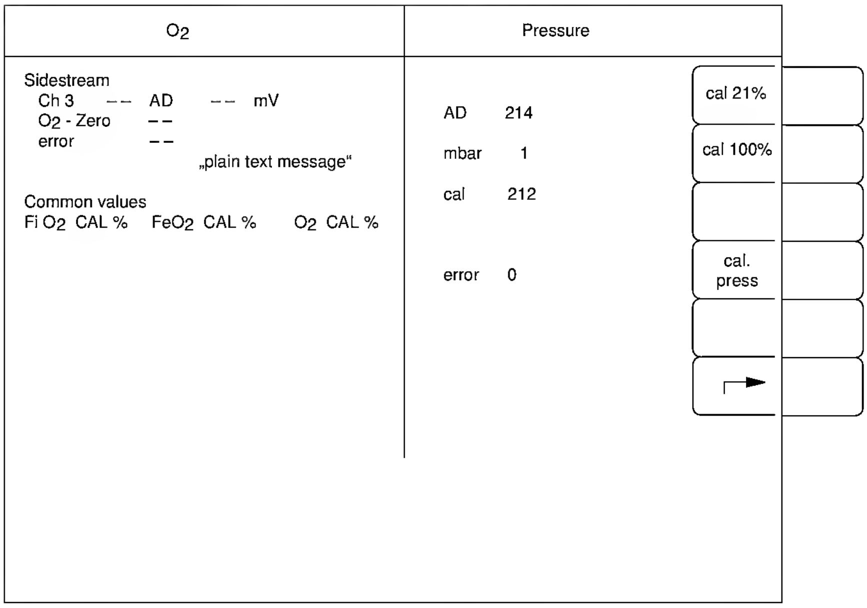
43.2 Service Mode 2



Self-test results	Error messages during power-on self test.
EDOS hours	EDOS operating hours (MAN/SPONT, IPPV and PCV). EDOS operating hours will only be displayed if Service Mode has been selected after power-on.
Vent. hours	Ventilator operating hours (IPPV/PCV). Ventilator operating hours will only be displayed if Service Mode has been selected after power-on.
serial 1,2,3 check	Check of serial “RS 232” interfaces located on rear panel. For each test it is necessary to short-circuit pins 2 and 3.
analogue out check	Check of analog interfaces. Preset voltage is available at outputs.
config reset	If this reset is carried out, the whole RAM contents will be deleted. This includes log, time, date, customer settings, all calibration values, and pressure sensor calibration value.
⮣	Pressing this softkey returns to first Service Mode page (applies to all Service Mode pages).



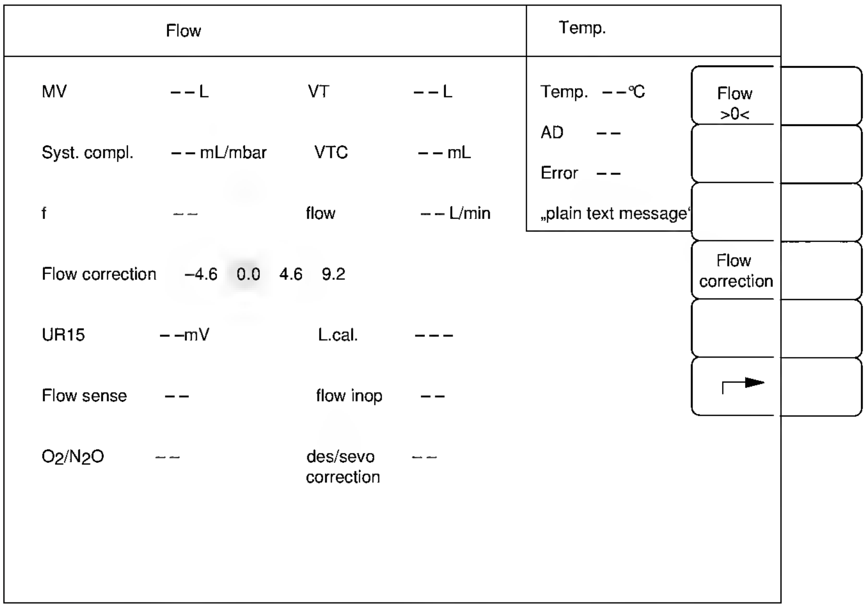
43.3 FiO_2/Pressure



Ch 3	Displays sensor voltage of O_2 sidestream measurement. 21% O_2 correspond to 10–21 mV, and 100% O_2 correspond to 48–91 mV.
O2 - Zero	Measured offset value on Measured Value PCB. Under normal conditions, it is between 200 and 250.
O2 error	1 Unstable offset voltage 2 Unstable calibration value 3 Calibration constant is off range 4 Calibration data stored in the TKRAM is invalid 5 Sensor voltage is too low 6 Sensor voltage is too high 7 No sensor available 8 Plausibility error in connection with agent analyzer 9 Calibration interrupted (leak test or similar) 10 Zero switch is defective 11 Anesthetic gas error 12 No O_2 measurement (condensation on O_2 diaphragm or similar)
FiO2	Displayed values correspond to current O_2 concentration. “CAL” is displayed during calibration procedure, “INOP” is displayed if an error has occurred or if no sensor is connected.
AD	Decimal value of A/D converter channel.
cmH_2O/mbar	Measured pressure in mbar. Range: –10 mbar to 99 mbar.
cal	Calibration value of A/D converter channel.

Calibration error	Pressure measurement error code. 0 = no error. 1 = P > 100 mbar 2 = P < –10 mbar 4 = pressure during calibration is too high 5 = pressure during calibration is too low

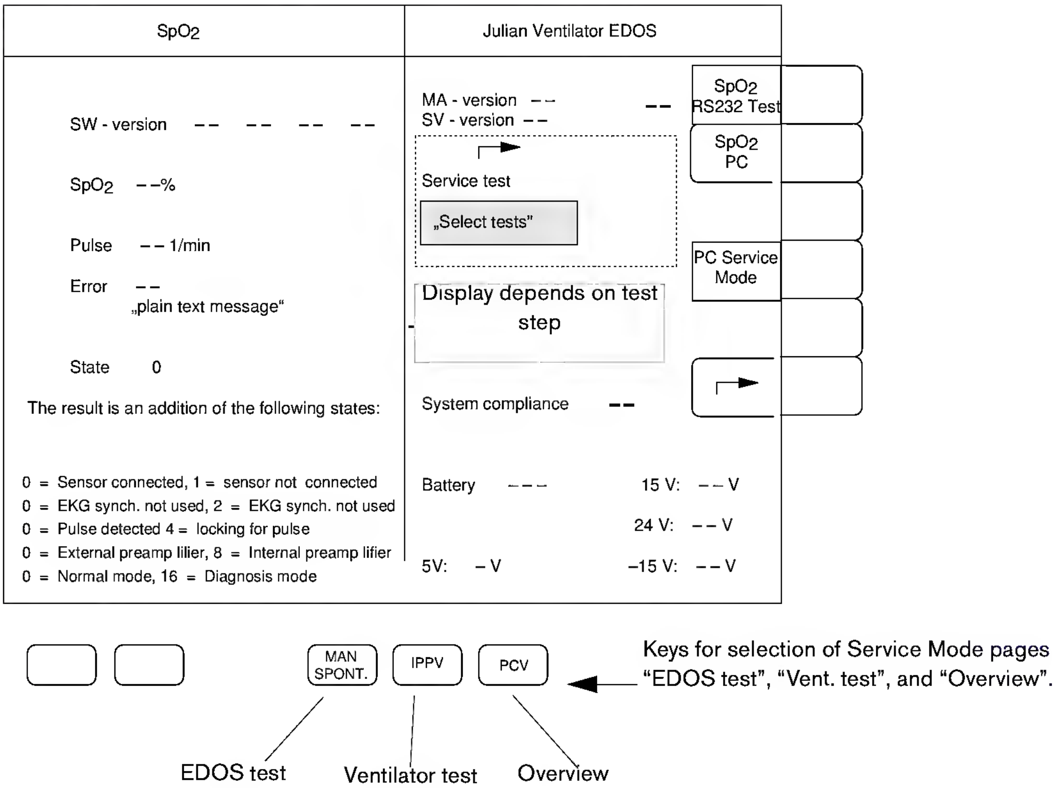
43.4 Flow/Temperature



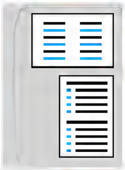
MV	Minute volume in L/min.
V_T	Tidal volume in mL.
Syst. compl.	System compliance value.
VTC	Currently not used in Julian.
f	Ventilation frequency in 1/min.
Flow	Current flow value in L/min.
Flow correction	This correction factor is used to compensate for deviations in flow measurement at higher altitudes. Factor is shown in %.
UR15	Voltage across 15 ohm resistor of flow measuring bridge. After calibration, this value should be between 1005 mV and 1015 mV.
Flow sense	Value of ground line voltage of flow sensor. This voltage should be between –20 and +20.

flow inop	Voltage within flow measuring bridge at calibration converter of the flow module. After successful calibration, value should be between 38 and 518.
L.cal.	Decimal value of calibration D/A converter of flow measurement bridge. Optimum value is between 500 and 2000. If value is not within this range, measurement of flow gives lower or higher results.
des/sevo correction	Factor for correction of desflurane or sevoflurane measurement.
O2/N2O	Display Gas type O_2/N_2O 16 100% 14 AIR 12 85% 10 76% 8 67% 6 57% 4 47% 2 36% 0 24%
Temp.	Measured temperature in °C.
AD	Digital value of A/D-converter channel of temperature measurement. < 20°C INOP 20°C approx. 780 34°C approx. 490 40°C approx. 334
Error	Temperature measurement error code. 0 = OK 1 = short-circuit 2 = interruption

43.5 SpO_2/Julian Ventilator EDOS



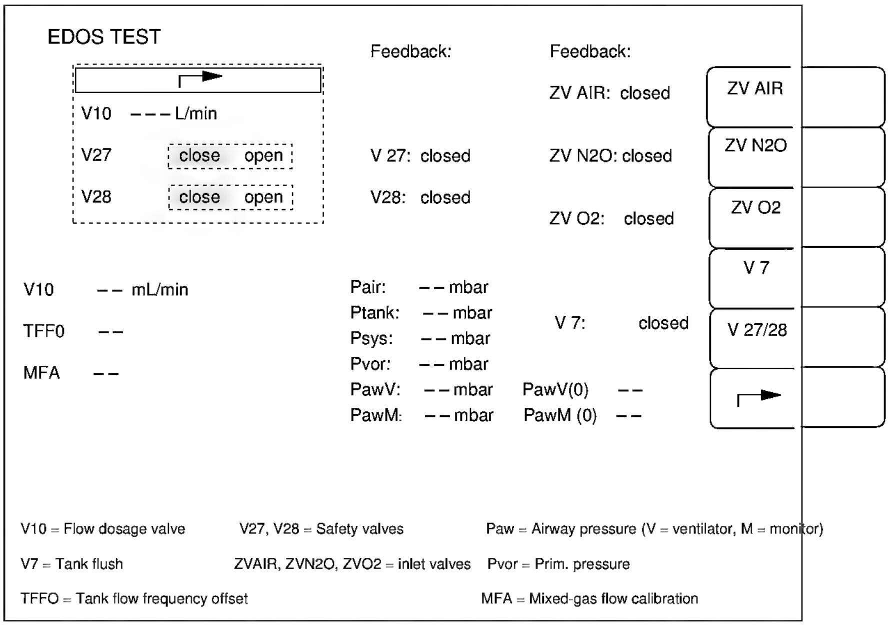
SW - version	For example, “Minisoom V 1.0” means Minisoom PCB, version 1.0, from Nellcor.
SpO2	Measured value of SpO_2 saturation in %.
Pulse	Pulse frequency in 1/min.
Error	Error code of SpO_2 module. Code not specified yet.
State	SpO_2 module status message.
MA - version SV - version	Software version of supervisor and master on Ventdos Controller PCB.
Service test	This function allows you to select individual power-on self tests using rotary knob when selecting Service Mode after power-on.
Service test results	Display of power-on self test number and of error codes from MASTER and SUPERVISOR.
Battery	A/D converter value of battery voltage. Normal: 103 to 956 (during battery operation). Equation: Voltage in V = $15 + \frac{\text{displayed value x 15}}{1024}$



5V, etc.	Display of pneumatics assembly operating voltages.
SpO2 RS 232 Test	Test of RS 232 interface to SpO_2 PCB. It is necessary to jumper RXD and TXD.
SpO2 PC	Not used by DS.
PC Service Mode	Download key. Press key. Switch Julian off. Switch Julian on. Carry out download.

43.5.1 EDOS Test

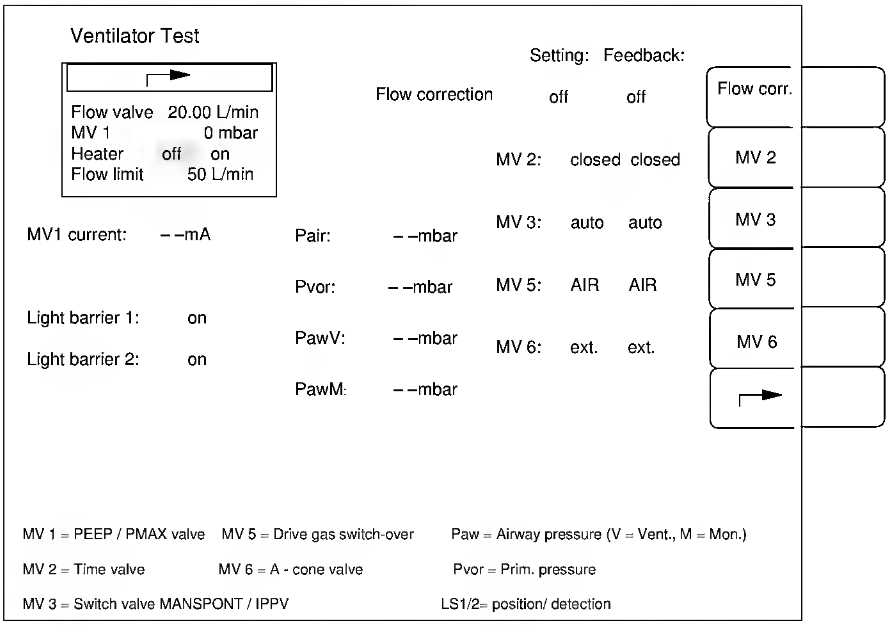
- Select test using "MAN/SPONT" key.



V10	Displays and adjusts value of V10 (target value) in the range of 0 to 12 L/min.
V27, 28	Toggles valves V 27, 28 on or off (can be set to static and switched individually).
V10	No display
TFFO	Displays frequency offset of container flow. Pressure sensor measured value (ΔPmix) is converted into frequency. Value is displayed in steps of 10 ms. Target value: 10>value>100. Value is measured only during power-on self test.
MFA	Displays mixer gas flow calibration value. Value is measured only during power-on self test. Value is 0.XXX, displayed as XXX. Target value: 750<displayed value<1000.
Pair, etc.	Display values of pressure sensors.
Feedback	Displays actual status of valves (electrical).
"ZV AIR" key, etc.	Used to activate respective valves.
PawV (0) PawM (0)	Calibration value of airway pressure sensors: PawV (0) is not displayed in software version "1.n". PawM (0) 150 - 250

43.5.2 Ventilator Test

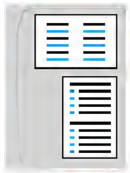
- Select test using "IPPV" key.

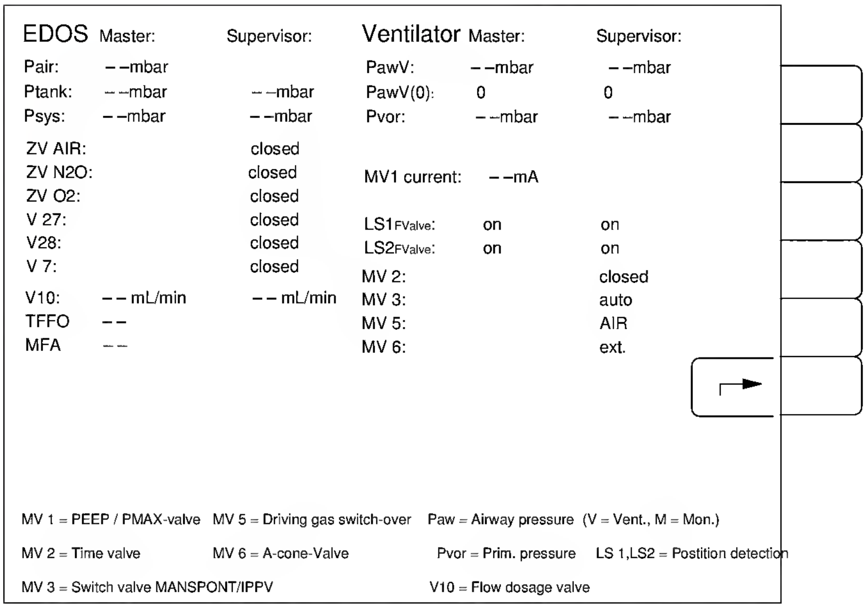


Flow valve	Displays and adjusts flow valve value (1 to 75 L/min).
MV1	Displays and adjusts MV 1 value (0 to 100 mbar).
Heater	Switches heater on or off.
Flow limit	Maximum flow limit in the PCB mode.
MV1 current	Displays control current for MV1 (approx. 90 to 470 mA).
Light Barrier 1	Light barrier 1 of flow valve.
Light Barrier 2	Light barrier 2 of flow valve.
Pair, Pvor, etc.	Displays values of pressure sensors (absolute pressure, Paw = airway pressure).
Setting/Feedback	Displays settings of MV 2, MV 3, MV 5, and MV 6 including respective feedback (electrical).
Flow corr.	Flow correction. Allows to compensate for pressure fluctuations.
MV 2, MV 3, MV 5, MV 6 keys	Can be used to activate the respective valve.

43.5.3 Übersicht EDOS und Ventilator

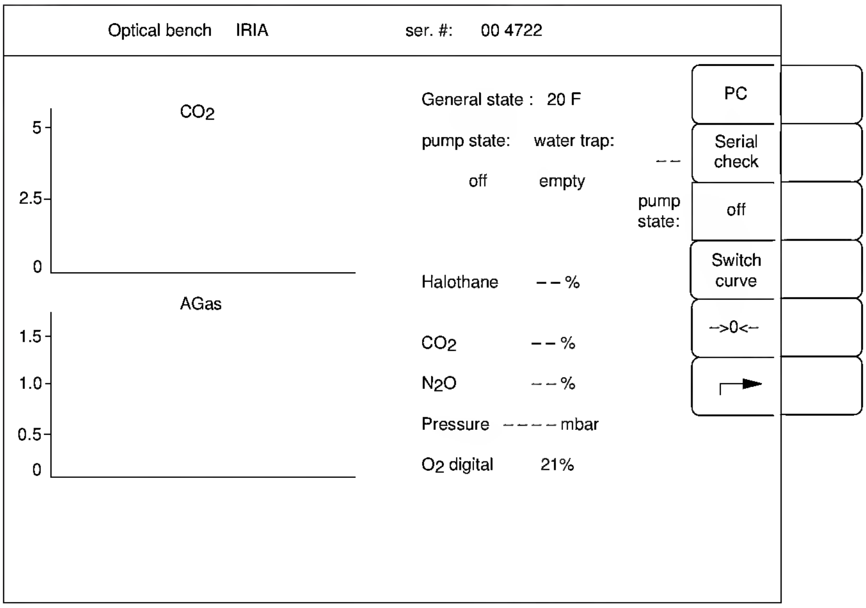
- Selektieren Sie den Test mit der Taste „PCV“.



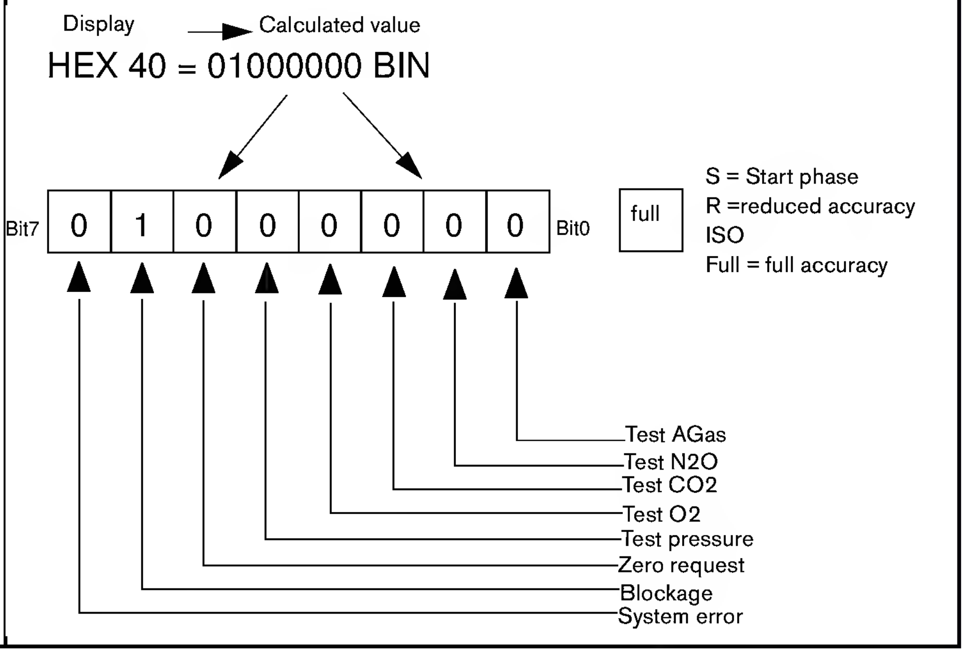


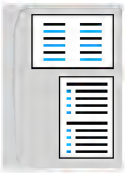
Master / Supervisor	Feedback from processors located on VentDos-Controller PCB.

43.6 Agent Analyzer (optical bench)



ser. #	Serial no. of agent analyzer. If serial no. is displayed, communication is OK.
General state	The agent analyzer status message is displayed as hexadecimal value (HEX). If for example "40" is displayed, convert the hex value into a binary value (BIN) first. Use the following matrix to allocate the respective status to the bit set to "1". In our example the status would be "blockage". If several (BIN) "1" occur, this may result in a combination of status messages.





OFF	Pump flow setting: (OFF, low, high, PURGE) **During automatic calibration of sidestream O_2 cell, pump flow setting is deactivated**.
AGas	Anesthetic gas value from agent analyzer and display of type of anesthetic agent.
CO2	CO_2 value from agent analyzer.
N2O	N_2O value from agent analyzer.
Pressure	Pressure value (absolute) in agent analyzer (cuvette pressure).
O_2 digital	O_2 value used for compensation of measurement. This value can be adjusted by pressing rotary knob, turning rotary knob to calibration gas value, and pressing rotary knob again to confirm.
PC	Changeover of communication from IRIA/monitor to IRIA/PC. In PC mode, monitor screen is “frozen”.
serial check	For repairs: Serial interface to agent analyzer can be checked by disconnecting connecting cable to agent analyzer and by jumpering RXD and TXD.
switch curve	Toggles bottom curve between N_2O and anesthetic gas.
>0<	Triggers zeroing of agent analyzer.

44 Electronics Error List

Contents

45 General Service Information

Error analysis by telephone/facsimile

Julian service technicians can get technical support at the following telephone/facsimile numbers:

		Product Supporter
Phone	(+49) 451 882-	3523 (Waletzko, Raimund)
		4392 (Weng, Andreas)
		3980 (Maxeiner, Björn)
Fax	(+49) 451 882-	4413

In the event of equipment failure, supply the following data to Lübeck for error analysis:

- Location/customer
- Serial number of Julian (can be found behind the breathing system)
- Software version
- Detailed description of the error
- Test step and master/supervisor codes if error has occurred during the self-test
- Contents of the error log in the service mode
- For problems involving IRIA: contents of the IRIA log (can be read out with IRIA service software)

The error log in the service mode can be read out with a laptop computer using the service software. If the equipment selection list does not contain this Julian software, enter the log addresses in a configuration file (see chapter "Julian does not appear on selection list").

Julian V_T measurement

The flow sensor of Julian is calibrated automatically. Customers can no longer perform manual calibration. A CO_2 signal is required for the Autocal function. Testing of the flow measurement (e.g with a test thorax) therefore requires manual flow-sensor calibration after completion of the self-test in the service mode.

With respect to flow measurement, note that Julian (software version 1.04 or earlier) provides compliance compensation but not compliance correction. During compliance compensation a fixed V_{TC} of 35 mL is added to the set V_T. When checking, allowance therefore has to be made for this V_{TC} as well as the ratio of the compliance of the breathing system and test thorax (refer to Julian Test Certificate, test items 23.1, 23.2, 23.2.4). Deviations due to altitude can be compensated by means of a correction factor in the service mode menu "Flow". Compliance compensation is available in software 2.02 or later.

Central supply (CS) system inlet valves

The CS system inlet valves ZV1 (AIR), ZV2 (N_2O) and ZV3 (O_2), item no. M23944, are located on the EDOS gas block (item no. AF00215) of Julian. They are pre-set by the valve manufacturer such that the required flow rate is obtained. If such a CS system inlet valve is defective, replace it as a complete assembly with a new CS inlet valve. Do not disassemble such a CS system inlet valve. Also, do not mount it or tighten it at the knurled edge (see also repair information, chapter 11.2 "Incorrect Assembly of Clippard 2/2-Way Valves (M32944)"). The specified CS system inlet valve flow rate can no longer be guaranteed if a CS system inlet valve has been disassembled and then re-assembled.

Software 1.01: Use of an external monitor (e.g. Vitara) at the Julian Medibus interface

Julian units with software version 1.01 should not to be connected to an external monitor via the Medibus interface. This may occasionally cause Julian to switch to safety mode (possible error codes in log: 9100, 11115, 11228).

Cause: Error in software version 1.01.

Remedy: Install software 1.02 or higher.

Software 1.01: Self-test message "backup battery defective"

The message "backup battery defective" may occur at the end of the self-test with software version 1.01, although the batteries in the power supply unit are OK.

Cause: The software generates the above message if the charging current is very low (batteries fully charged).

Check batteries: Disconnect the power plug from mains supply during operation. The battery charging display should appear at the top right of the screen and should be between 90 and 100%.

Remedy: This problem has been solved in software 1.02 or higher.

Software 1.01: **Error in self-test, test step 255**

Julian may stop in test step 255. There are no problems with the next power-on test.

Cause: Error in software error 1.01.

Remedy: Install software 1.02 or higher

Software 1.01: **Operation at high altitude**

Various error messages may be displayed during the self-test if Julian is used at high altitude due to the different ambient pressures. Such errors occur if the breathing system is vented but the residual pressure is > 4 mbar.

Cause: The 1800 mbar pressure regulator upstream of Psupply is adjusted at ambient pressures of approx. 1013 mbar. The absolute pressure measured at Psupply is therefore roughly 2800 mbar. High altitudes produce a change in ambient pressure and thus also in absolute pressure, which affects the control behavior of the PEEP valve.

Remedy: With software 1.01 - adjust supply pressure Psupply in service mode "ventilator test" to between 2750 and 2850 mbar (set flow valve to 20 L/min.) with MV2 switched.

With software 1.02 or higher - software compensation for fluctuations in ambient pressure affecting control behavior of PEEP valve.

Software 1.01: **Mixer INOP due to inadequate CS system pressure**

A drop in the CS system pressure to below 2.7 bar (e.g. when filling the reservoir) results in the message "Mixer INOP" with software 1.01. Julian switches to safety mode (log entry 11208).

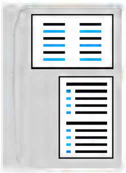
Remedy: In software 1.02 or higher, such situations will only generate a gas shortage alarm. Julian will no longer switch to safety mode.

Leak test from standby mode

Software 1.02 or higher: The leak test is implemented from standby.

A-cone operation

Software 1.02: It will be possible to switch directly from A-cone operation to PCV, IPPV or standby.



46 Reading Out Error Log via Laptop Computer

DrägerService software ≥ 9.3 must be installed.

46.1 Reading Out Error Log (Software 1.03 or Earlier)

46.1.1 Preparing Julian

NOTICE:

Prior to changes, record interface parameters and reset them on completion of the test.

- Allow Julian to complete self test.
- Switch Julian to "Standby/Configuration" mode.
- Call up menu: Standard values -> Interfaces -> Config. of: COM1.
- Set protocol selection to "Printer"
- Set baud rate to "9.6"
- Set parity to "None"
- Set data bits to "8"
- Set stop bits to "1"
- Switch monitor to standby mode.

46.1.2 Preparing Laptop Computer

Is DrägerService software ≥ 9.3 installed? Is the printer connected to the laptop computer? (Only if you want to print out log). Is the laptop computer connected to the printer interface (COM1) of Julian (test cable RS232 extension 7901808)?

- Start service software.
- Call up unit selection "Julian".
- Call up function selection "print log".

46.1.3 Using the Software

Start "print log" program.

- Choose unit to be read out -> Select Julian and press {Enter} to confirm. (If Julian is not on selection list, proceed as described under "Error Sources", item Julian does not appear on selection list).
- When "Command: read log" appears in command line, press only {Enter}.
- Log addresses could be altered, but press {Enter} only.
- Enter unit serial no., for example "ARHD-0035", and press {Enter}.
- If "ERROR.LOG file already exists. Overwrite..." is displayed -> press {Y} and press {Enter}.
- Error log is read out line by line and then appears on laptop screen.
  Note: Message "Timeout" may appear if there are data transmission problems. Reference to possible errors is made in the "Error Sources" section.
- Press {↑}, {↓}, {PgUp}, {PgDn} to scroll through log or {Esc} to exit this display mode (exiting will not delete log).

Printing Out Log

- Make sure log has been read out and is displayed on screen.
- Press {Esc} -> Log disappears from screen.
- Press {↑} to select "Print log" command and press {Enter} to confirm. Press {Enter} again to start printing via LPT1 port. The log is printed.

Saving Log to a Floppy Disk

- Make sure log has been read out and is displayed on screen.
- Press {Esc} -> Log disappears from screen.
- Insert a floppy disk into drive A.
- Press {↑} to select "Copy file" command and press {Enter} to confirm.
- Drive name and file name under which log will be saved are shown in the command line -> A:\ERROR_cp.log). You may now change drive and/or file name, if applicable. If you press {Enter} without entering a new drive and/or file name, log will be saved to floppy disk under the name "ERROR_cp.log").
- Press {Esc} to exit program.

46.1.4 Error Sources

Julian does not appear on selection list

- Using any text editor, add following lines to end of "ERRLOG.DEV" file located in directory "C:\Service\Errlog.MT" of laptop computer and save file:
  [Julian 1.0x]
  0401B6
  0401B8
  0401BC

Example:

Laptop is in MS-DOS mode. Service program has not been started. To open file, enter the following DOS command.

- "Edit C:\Service\Errlog.MT\ERRLOG.DEV" and press {Enter}.

The file is opened.

- Press {↓} to go to end of text, insert a new line, and enter the above mentioned lines.
- To save changes to file -> press and hold {Alt} and press {F}. Then press {↓} to select "Save" and {Enter} to confirm.
- To exit text editor -> press and hold {Alt} and press {F}. Then press {↓} to select "Exit" and {Enter} to confirm.

"Timeout" During Data Transmission

- Correct interface cable? Pin 2 to pin 2 and pin3 to pin 3.
- Wrong laptop computer port selected -> Press {Esc} and then select command "rs232" by pressing {↑}. Press {Enter}. Toggle between Com1 and Com2 ports by entering {2} or {1} and press {Enter} to confirm selection. Enter "Save" and press {Enter}. Press {↑} or {↓} to call up "Read log" command and continue as described above.
- Laptop computer is connected to RS232 interface of monitor.
- Monitor is not in standby mode.

46.2 Reading Out Error Log (Software 1.04 or Later)

With software versions 1.04 and 2.02 the error log can be additionally be read out via the Medibus. With software version 3.0 the error log can only be read out via the Medibus interface.

As of Julian software version 3.0, the IRIA error log must be read out using the VISIA program (see "Reading out the IRIA error log as of software version 3.0 with VISIA" on page158).

46.2.1 Reading Out Error Log via Medibus

To be able to read out the error log Julian must be in self-test mode after the check list, in standby, or in an operating mode. It is no longer necessary to configure the interface. The interface on Julian is now COM2.

- Connect the laptop computer to Julian interface COM2.
- Start the service program "Error log via Medibus PM 8060/Julian" from the "PM 8050/60 Julian" menu on the laptop computer. If the error log is not read out immediately, change the baud rate in the error log readout program to 1200 or 9600.
- Enter Julian's serial number.
  Save or print error log.

47 Additional Known Errors

47.1 Safety condition when changing a ventilation mode (SW 3.02)

If the Julian error log displays a safety condition plug error codes 11115 and 11116, then it is **not** a hardware fault. A typical error sequence would be 11228, 11129, 11115, 12032, 12029, 11116.

Caution:

If you change the default value of a parameter after selecting a ventilation mode, observe the following:

You must wait until the new value is shown on the softkey **before** you confirm the ventilation mode by pressing the control knob.

If the changed parameter is not yet updated on the screen when confirming the ventilation mode, pressing the control knob twice very fast can switch Julian to emergency flow.

If this should happen, Julian can be restarted without any problems and anesthesia delivery can be continued.

47.2 Self-test message "pressure safety valve incorrectly adjusted"

The message "pressure safety valve incorrectly adjusted" may occur in test step 23. This error is generated if a maximum airway pressure > 95 mbar (desired value 75 - 95 mbar) is measured when checking the safety valve.

Cause: The opening pressure of the current safety valve is sometimes higher than 95 mbar. The pressure is within the dynamic tolerance range.

Check: In the event of an error, check adjustment of pressure safety valve. This should be done according to the Julian Test Certificate (start test step 23 in service mode).

Stepper motor of slot valve/proportional valve missing steps

The stepper motor of the slot valve may miss several steps in the event of frequent adjustment of the V_T or I:E ratio due to component tolerances on the Ventdos Actuator PCB. This leads in the event of minor deviations from the set value to an inadequate V_T. Major deviations cause the Julian to switch to safety mode. Possible entries in the error logbook are then codes 11201 and 11228, which must be entered within 30 seconds of one another.

Remedy: A hardware modification on the Ventdos Actuator PCB will be retrofitted on site as part of software conversion to version 1.02.

Pressure fluctuations at Psupply

The pressure sensor Psupply is mounted on the slot valve, which is not earthed. Problems may occur with the pressure channel Psupply due to the absence of earthing. Julian thus detects a ventilation frequency which does not correspond to the set frequency. Julian displays "Mixer INOP" and switches to safety mode (error entries 11201 **and** 11202 immediately after one another).

Remedy: Earth the slot valve; refer to Julian Service Bulletin IDM no. 2 (see Service Bulletin).

Anesthetic gas measurement, INOP deactivation of IRIA pump

Excessively high supply voltages or interference pulses can lead to switch-off of the IRIA pump. Anesthetic gas measurement is OK again after switching Julian off and on.

Cause: DC/DC converter or software, Flow PCB of IRIA module

Remedy: Entries in **IRIA** log: 1117, 1119, 4000 -> measure supply voltage (11.0 to 12.6 V)

Entry in **IRIA** log: 3517 -> check software version of Flow PCB (01.02)

Operation with real gases

- If AIR is used as gas supply instead of N_2O and if a high N_2O concentration/flow is set with the gas mixer, Julian may display "Vent INOP" ("Mixer INOP" with software versions 1.02 or earlier) and switch over to safety mode.
  Cause: When mixing gases, Julian detects a difference between the measured mass flow and the pressure increase in the reservoir.

  Remedy: Set the O_2 concentration to 100% or switch to a different type of gas (AIR).
- If O_2 is connected to the CS-AIR inlet instead of AIR (for example via the O_2 test gas cylinder), an error message may occur in test step 16 of the self-test sequence. An excessive mixer flow calibration value is measured during calibration of the sintered screen.

  Remedy: Connect the AIR supply or depressurize the CS-AIR inlet.

IRIA sample gas return hose

The internal silicone sample gas return hose may become kinked immediately at the connection socket when inserting the ventilator after a repair. The function of the IRIA should therefore always be tested when ventilator repairs have been performed.

48 Errors in the Service Mode with Software 1.01

Menu: IRIA - automatic anesthetic gas recognition

If Julian is equipped with software 1.01, the anesthetic gas is not automatically recognized in the IRIA service menu. The anesthetic gas channel can only be checked using a laptop computer and the service software or in the MAN/SPONT operation in the HLM mode. This problem can be solved by updating to software version 1.02.

Menu: Ventilator test - flow correction

The flow correction in the ventilator test service menu has no function with Julian software 1.01 and 1.02. When checking the flow valve, allowance must be made for the influence of Psupply pressure fluctuations (flow-valve actual value = flow-valve set value * Psupply/1.8 bar). Refer to Julian Test Certificate, item 12., checking driving flow.

Menu: Service2 - interface test

The interface test Com3 has no function.

Menu: VentEDOS

The voltages are not displayed.

Menu: Ventilator test and Edostest - Pair

The pressure value Pair is zeroed at ambient pressure and no absolute value is displayed.

Menu: Ventilator test - MV6

MV6 feedback has no function.

Menu: General list

Various supervisor measured values are incorrect or not displayed.

49 Modifications in the Service Mode with Software 1.02

IRIA menu

Water-trap level detection is displayed.

VentEDOS menu

Self-test steps can be started individually.

50 Error Code Lists

50.1 Information in the Error Log

Julian’s error log may include 3 different types of information:

– Error entries

– Entries which describe Julian's reaction to errors

– Debug information from the development department

50.2 Examples of Log Entries

The latest entries are on top of the log. A faulty mixed gas flow would generate the following log entries:

no.	code	modulID	taskID	line no.	day	time
10.	11228	vtd	Vnt_	4679	09-11-99	09:20:42
11.	11206	vtd	Vnt_	4679	09-11-99	09:20:41
12.	11129	vtd	Vnt_	4679	09-11-99	09:20:41
13.	12032	vtd	Vnt_	4617	09-11-99	09:20:41
14.	11206	vtd	Vnt_	4679	09-11-99	09:19:26
15.	11466	vtd	Vnt_	4679	09-11-99	09:19:25
16.	11136	vtd	Vnt_	4679	09-11-99	09:19:25
17.	11348	vtd	Vnt_	4679	09-11-99	09:19:25
18.	12023	vtd	Vnt_	5055	09-11-99	09:18:58

50.2.1 Evaluating Log Entries

The following table explains the meaning of the log entries in chronological order.

Code	Meaning
12023	The Vent/EDOS (ventilator, electronic flow control) generates a warm start. Entered by monitor. Entry is done by monitor because the Vent/EDOS cannot enter codes during its own warm start.
11348	Approx. 30 s after the warm start of Vent/EDOS, the master processor of the Ventdos-Controller PCB enters the following: "Reset due to internal watchdog", normal prior to reset, normal from monitor after reset. The internal watchdog is used by the Ventdos-Controller PCB master to initiate a warm start. The master processor and the monitor were in normal mode prior to and after reset (Man/Spont, IPPV, PCV).
11136	The supervisor also generates a reset which is recognized by the master. A warm start of the master always triggers a warm start of the supervisor.
11466	The supervisor reset was an "unknown reset" because it is carried out by the hardware, as for example in case of a operating voltage failure. The supervisor was also in the normal mode prior to reset.

Code	Meaning
11206	**This is the actual error code.** The measured mixed-gas flow is below the target value by more than 30%. In this case, the cause was a leakage in the ZVAir valve. Ptank decreased too slowly which indicated an insufficient fresh-gas flow. On first occurrence of this error, Julian reacts with a warm start. If the error occurs a second time within 10 minutes (line 11), Julian switches to safety mode.
12032	Vent/EDOS is in safety mode. Entered by monitor.
11129	Supervisor is in safety mode.
11206	Error has occurred again after approx. 70 s. Therefore, Julian switches to safety mode.
11228	Master is in safety mode.

When reading the error log list, keep in mind that the error cause (in this example,11206) does not appear on top of the list. Log sequences may also appear which lack a direct reference to an error. This may occur when the device cannot enter codes due to the error (for example, sudden voltage failure, external resets of processors, or communication problems on the CAN bus).

50.2.2 Recognizing the Software Version Using the Error Log

You can use the error log (line no. of 11000 codes) to recognize the software version of Julian.

line no.	Julian software version
4481	1.02
4490	1.03
4679	1.04
4149	2.02

50.3 Self-test: error code 00xx (CIO PCB)

Error no.	Description
0000	Nor error detected.
0001	Undefined error detected.
0002	Watchdog time is too short.
0003	Watchdog time is too long.
0004	Error occurred during initialization of the connection port.
0005	Default case construction reached.
0006	Error occurred during word-to-ASCII conversion.
0007	Database sends error message. Task idle.
0008	Database sends error message. Mbx overflow.
0009	Database semaphores are always busy.
0010	Unknown error type received.
0011	Connection to monitor task unsuccessful.
0012	Task was in the loop for too long.
0013	Timeout or timeout signal received.
0014	Database error occurred.
0015	Transmission message error occurred.
0016	Alarm confirmation does not function (Front PCB?).
0017	Checksum error in the error log.
0018	Power failure (mains failure, power supply unit?).
0019	Undefined watchdog reset. Possible cause: defective CIO PCB or DC converter.
0020	Error while system was booting.
0021	Not all boards are available.
0022	No Powerfail Interrupt detected. The powerfailFlag located in a volatile RAM area destroyed. Maybe by a voltage drop. But no powerfail interrupt was detected. ->Test and adjust the power supply !
0023	CPU RTC- Battery low -> Change Real Time Clock (PM8060: TKRAM).
0024	The RTC clock not running. ->Change Real Time Clock (PM8060: TKRAM).
0050	Error while initializing Timer A.
0100	Exception while system was booting.

50.3 Self-test: error code 00xx (CIO PCB) (cont'd.)

Error no.	Description
0201 - 0300	Software version 3.0 or later: Number of self-test aborts identified by: error code minus 200. Example: error code: 0201; that is 201 - 200 = 1 -> first self-test abort. Code 0300 is indicated if the number of self-test aborts exceeds100.

50.4 CIO PCB RAM test: error code 10xx

Error no.	Description
1000	RAM start is larger than RAM end.
1001	RAM start is not divisible by 4.
1002	RAM end is not divisible by 4.
1003	Error detected in the RAM during count-up.
1004	Error detected in the RAM during count-down.
1005	TKRAM is defective.
1006	TKRAM clock is probably defective.

50.5 CIO PCB MFP: error code 11xx

Error no.	Description
1100	Error occurred during initialization of the Multi Functional Processor (multi-function peripherals).
1101	Multi Functional Processor test failed.
1102	Multi Functional Processor interrupt test failed.
1103-1008	TKRAM is defective.
1109	EPROMs with new change status. Do both EPROMs have the same version?
1110	TKRAM contents saved after the watchdog test.
1111	TKRAM contents set to the default value after the watchdog test.
1112	TKRAM contents set to a new default value after the watchdog test.
1113	TKRAM test failed after the watchdog test.
1114	TKRAM battery is empty after the watchdog test.
1115	TKRAM test with new default values failed after the watchdog test.
1116	EPROMs have a new change status after the watchdog test.

50.6 Measured Value PCB: error code 20xx

Error no.	Description
2000	TXD channel 1 test failed.
2001	TXD channel 2 test failed.
2002	ROM test failed.
2003	RAM test failed.
2004	Dual Port RAM test failed.
2005	PIO test failed.
2006	CTC test failed.
2007	Watchdog test failed.
2008	Flow data test failed.
2009	Flow register test failed.
2010	+5 V test failed.
2011	+15 V test failed.
2012	Reference voltage failed.
2013	Z80 is defective. Case error occurred.
2014	No boot command received.
2015	No start command received.
2016	IRQ command error occurred.
2017	Command error occurred.
2018	No control data received.
2019	Incorrect control data received.
2020	Watchdog error received.
2021	Reset from data manager received.
2022	Incorrect command received.

50.7 SpO2 PCB: error code 30xx

Error no.	Description
3000	Module hardware error occurred.
3001	SpO2 task left the infinite loop.
3002	SpO2 cannot be reset.

50.7 SpO2 PCB: error code 30xx (cont'd.)

Error no.	Description
3003	SpO2 cannot be started.
3004	Writing different data into the database is not possible.
3005	Writing ASCII data into the database is not possible.
3006	Writing selection data into the database is not possible.
3007	Access to the semaphore in the database is not possible.
3008	Database input is corrupted.
3009	Received updating rate deviates from programmed rate.
3010	Configuring the UART for PC shortcut in the Service Mode is not possible.
3011	Reconfiguring the UART for the PC shortcut in the Service Mode is not possible.

50.8 CIO PCB: error code 40xx

Error no.	Description
4000	CIO PCB is defective or missing.
4001	DUART baud rate error occurred.
4002	DUART error during initialization occurred.
4003	DUART block A channel 0 is faulty.
4004	DUART block A channel 1 is faulty.
4005	DUART block B channel 0 is faulty.
4006	DUART block B channel 1 is faulty.
4007	DUART block C channel 0 is faulty.
4008	DUART block C channel 1 is faulty.
4009	DUART block D channel 0 is faulty.
4010	DUART block D channel 1 is faulty.
4011	DUART register test failed.
4012	DUART IRQ test failed.
4013	DUART handshake block B channel 0 is faulty.
4014	DUART handshake block B channel 1 is faulty.
4015	DUART handshake block C channel 0 is faulty.
4016	DUART handshake block C channel 1 is faulty.
4017	DUART handshake block D channel 0 is faulty.

50.8 CIO PCB: error code 40xx (cont'd.)

Error no.	Description
4018	DUART handshake block D channel 1 is faulty.

50.9 Front PCB: error code 50xx

Error no.	Description
5000	Front PCB is missing or not functional.
5001	Loudspeaker is not connected.
5002	LED port error occurred.
5003	Soundchip register test error occurred.
5004	LED port is faulty.
5005	Soundchip is faulty.
5006	Loudspeaker is faulty.
5007	Keypad is faulty.
5008	Control knob is faulty.

50.10 TI error messages: error code 51xx (Front PCB)

Error no.	Description
5100	Error occurred during TI initialization (Texas Instruments, graphics processor).
5101	Error occurred during the TI address bus low test.
5102	Error occurred during the TI address bus high test.
5103	Data bus test error occurred.
5104	Unexpected interrupt from the TI detected.
5105	Write error in the video RAM test pattern occurred.
5106	Communication error in the 3-bit message occurred.
5107	Checksum error in the TI code occurred.
5108	Download error in the TI code occurred.
5109	Execution speed of TI is off tolerance.
5110	No interrupt from the TI detected.
5111	Error occurred while downloading the TI application code.

50.10 TI error messages: error code 51xx (Front PCB) (cont'd.)

Error no.	Description
5112	Timeout. No response from the TI after displaying the test pattern.
5113	Display RAM is faulty.
5114	Code RAM is faulty.
5115	No response from the HOST to the TI-IRQ occurred.

50.11 TI error messages from ti_t.c > error code 52xx

Error no.	Description
5230	TI (Texas Instruments, graphics processor): dataQ failed.
5231	TI: DataQ failed.
5232	TI: RRequQ failed.
5233	TI: Length of character string is incorrect.
5234	TI: Length of the order list is incorrect.
5235	TI: Order list ID is incorrect.
5236	TI: Command unknown.
5237	TI: Reserve 1 is incorrect.
5238	TI: Reserve 2 is incorrect.
5239	TI: Data base alarm failed.
5240	TI: Alive token failed.
5241	TI: Last alive inquiry reached a timeout.
5242	TI: ASCII time setting failed.
5243	TI: Reserve 3 is incorrect.
5250	Service Mode timeout.
5251	Timer error.
5252	Undefined error
5253	Invalid data base action.
5254	Incorrect data base action

50.12 TI error messages from the TI code: error code 55xx

Error no.	Description
5500	TIsw: No error occurred.
5501	TIsw: Data_ID is unknown.
5502	TIsw: Group_ID is unknown.
5503	TIsw: Data attribute is unknown.
5504	TIsw: Event_ID is unknown.
5505	TIsw: Program counter is outside the code range.
5506	TIsw: Stack pointer is outside the stack range.
5507	TIsw: Stack violation: magic word occurred.
5508	TIsw: Watchdog time elapsed.
5509	TIsw: RAM test failed.
5510	TIsw: Checksum error.
5511	TIsw: Selection failed.
5512	TIsw: Set timer failed.
5513	TIsw: Miscellaneous 1 occurred.
5514	TIsw: Miscellaneous 2 occurred.
5515	TIsw: Host interrupt is missing.
5516	TIsw: Alive request is missing.
5517	TIsw: Order list shortened.
5518	TIsw: Spare 18 occurred.
5519	TIsw: Spare 19 occurred.
5520	TIsw: EventQ error.
5521	TIsw: EventQ is full.
5522	TIsw: Length of the RRequQ input is incorrect.
5523	TIsw: Chip reset occurred: pin3 is incorrect.
5524	TIsw: Local interrupt occurred: pin6 is incorrect.
5525	TIsw: Local interrupt occurred: pin7 is incorrect.
5526	TIsw: Win violation interrupt occurred.
5527	TIsw: TRAP 30 = invalid OP code received.
5528	TIsw: Spare 28 occurred.
5529	TIsw: Spare 29 occurred.
5530	TI<host: dataQ failed.

50.12 TI error messages from the TI code: error code 55xx (cont'd.)

Error no.	Description
5531	TI>host: dataQ is full.
5532	TI>host: RRequQ failed.
5533	TI>host: RRequQ is full.
5534	TI>host: get_sema failed.
5535	TI>host: rel_sema failed.
5536	TI>host: alarm confirm failed.
5540	Incorrect line type.
5541	Buffer.
5542	Compilation error.
5543	Unknown attribute.
5544	Unknown BP source.
5545	Unknown CO_2 source.
5546	Unknown NIBP source.
5547	Unknown format.
5548	Source is full.
5549	Incorrect message from DM.
5550	As of SW 3.0: Pxcheck: suggested search too short
5551	As of SW 3.0: Pxcheck: invalid setting
5552	As of SW 3.0: Pxcheck: section corrupt
5553	As of SW 3.0: Pxcheck: fields ambiguous
5554	As of SW 3.0: Pxcheck: fields in disarray
5555	As of SW 3.0: Pxcheck: number renaming failed
5556	As of SW 3.0: Pxcheck: error occurred
5557	As of SW 3.0: Pxcheck: temporary error 1
5558	As of SW 3.0: Pxcheck: temporary error 2
5559	As of SW 3.0: Pxcheck: temporary error 3
5560	As of SW 3.0: GUI: selection map error
5561	As of SW 3.0: GUI: deregister error
5562	As of SW 3.0: GUI: register error
5563	As of SW 3.0: GUI: register error
5564	As of SW 3.0: GUI: invalid area of focus manager
5565	As of SW 3.0: GUI: invalid area of focus manager

50.12 TI error messages from the TI code: error code 55xx (cont'd.)

Error no.	Description
5566	As of SW 3.0: GUI: ASCII 4 map error
5567	As of SW 3.0: GUI: ASCII 4 deregister error
5568	As of SW 3.0: GUI: GSP: entered presetting area
5549	As of SW 3.0: GUI: Spare 69
5999	TI: Last error reached.

50.13 Anaesth. gas bank and anaesth. gas: error code 60xx

Error no.	Description
6000	Fatal error occurred: Reset bank. Replace bank. Check general status. If necessary, use calibration and/or repair software.
6001	Bank self-test error occurred. Replace bank. Check general status. If necessary, use calibration/repair software.
6002	State flags of the pump in the Andros pneumatics status byte do not have the expected status. This occurs frequently during changeover of the pump. If the error is constant, error 6000 will be generated.
6003	Valve state flags in the Andros pneumatics status byte do not have the expected status. This occurs frequently during changeover of the valve. If the error is available constant, error 6000 will be generated.
6004	Anaesth. gas state flags in the Andros pneumatics status byte do not have the expected status. This occurs frequently when changing over to another anaesth. gas. If the error is constant, error 6000 will be generated.
6005	Bank zeroing error occurred. Check cuvette, valve. CO2 present in the in the system during zeroing?
6006	UART cannot be initialized.
6007	AGA: micro command wait loop error
6008	AGA: command step error
6009	Bank does not respond.
6010	Selection database contains incorrect data.
6011	Cannot write selection database.
6012	Selection database will send no messages.
6013	Cannot write ASCII4 database.
6016	Cannot configure UART for PC or laptop. I/O PCB defective?
6017	Cannot reconfigure PC-UART (for laptop). I/O PCB defective?

50.13 Anaesth. gas bank and anaesth. gas: error code 60xx (cont'd.)

Error no.	Description
6018	UART cannot send data.
6019	Cannot read selection database.
6020	Cannot read ASCII4 database.
6021	Anesthetic gas recognition program sent timeout.
6022	Continuous data stream sent timeout. Dashes in Andros data. Motor shows deviations from the target speed for a very short period. This can occur occasionally.
6024	Start-up program not completed (boot phase).
6025	Bank does not recognize the type of anesthetic. Result: INOP.
6026	Zero error, general status byte 80, cable, measured values are not as specified. Deviations from the target speed for a longer period. Result: INOP.
6099	AGA incorrect communication protocol

50.14 Measured Value PCB: error code 80xx (software error)

Error no.	Description
8000	Measured Value PCB is missing.
8001	Software version is incorrect (error during AIRMESS initialization).
8002	Calibration error occurred. Z80 transmitted incorrect calibration data. Sensor is INOP.
8003	Error occurred while writing fast data into the database.
8004	Z80 reset triggered by data manager.
8005	Incorrect calibration data stored in the TKRAM was sent to the airway manager. Sensor is INOP.
8006	Data manager cannot write new commands into the airway manager.
8007	Data manager received incorrect control data.
8008	No control data sent within a specific time.
8009	8ms duration of Z80 is incorrect.
8010	Z80 does not cancel the old Air_sema_slow.
8011	Z80 does not create interrupts.
8012	Signal sent to airm task.
8013	Z80 error boot is not ready. EPROM version? Dual port RAM is defective.

50.14 Measured Value PCB: error code 80xx (software error) (cont'd.)

Error no.	Description
8014	EPROM has incorrect version. No interrupt detected by Z80. Dual port RAM is defective.
8015	Incorrect communication to Z80 received.
8016	Timeout: no response from AIRMESS (Z80) received.
8017	Rosy function returned received error.
8018	Z80 detected error 1.
8019	Z80 detected error 2.
8020	Z80 detected error 3.
8021	Z80 detected error 4.
8022	Z80 detected error 5.
8023	Z80 detected error 6.
8024	Z80 detected error 7.
8025	Z80 detected error 8.
8026	Z80 detected error 9.
8027	Z80 detected error 10.
8028	Z80 detected error 11.
8029	Z80 detected error 12.
8030	Z80 detected error 13.
8031	Z80 detected error 14.
8032	Z80 detected error 15.
8033	'Z80 detected error' not identified.
8034	Error occurred while creating fast alarms.
8035	Timeout with Airo tasks reached.
8036	ASCII4 compare always returns errors.
8037-44	Error occurred during flow sensor calibration.
	Fast O2 measurement.
8051	Zero voltage is not OK. Measured Value PCB.
8052	Data during calibration are not stable.
8053-8054	Calibration data is invalid.
8055-8057	Sensor voltage is too low, too high, or sensor is missing. Replace the sensor.
8058	Plausibility check during operation is incorrect. Replace the sensor.

50.14 Measured Value PCB: error code 80xx (software error) (cont'd.)

Error no.	Description
8059	Calibration of CPU PCB aborted.
8060	Error of the zeroing switch Ch3 Measured Value PCB.
8061	O2 error as a result of an Andros error.
8062	O2 does not recognize a respiratory phase. Replace the sensor. Condensation on diaphragm.
8063	Unknown error.
8064	No I:E signal (occurs after a warm start).

50.15 Watchdog: error code 90xx (CIO PCB software error)

Error no.	Description
9000	Insufficient watchdog counters.
9001	Index of the counter cannot be calculated.
9002	Watchdog counter overflow.
9003	Watchdog counter is blocked.
9004	Odd value for watchdog counters is outside range.
9010	Watchdog counter overflow from idle_taskID detected.
9011	Watchdog counter overflow from moni_taskID detected.
9012	Watchdog counter overflow from airo_taskID detected.
9013	Watchdog counter overflow from airm_taskID detected.
9014	Watchdog counter overflow from ti_taskID detected.
9015	Watchdog counter overflow from tiup_taskID detected.
9016	Watchdog counter overflow from agam_taskID detected.
9017	Watchdog counter overflow from agao_taskID detected.
9018	Watchdog counter overflow from agad_taskID detected.
9019	Watchdog counter overflow from prt_taskID detected.
9020	Watchdog counter overflow from prtt_taskID detected.
9021	Watchdog counter overflow from medatabase_taskID detected.
9022	Watchdog counter overflow from medt_taskID detected.
9023	Watchdog counter overflow from com_taskID detected.
9024	Watchdog counter overflow from mio_taskID detected.
9025	Watchdog counter overflow from alrm_taskID detected.

50.15 Watchdog: error code 90xx (CIO PCB software error) (cont'd.)

Error no.	Description
9026	Watchdog counter overflow from deb_taskID detected.
9027	Watchdog counter overflow from aup_taskID detected.
9028	Watchdog counter overflow from divt_taskID detected.
9029	Watchdog counter overflow from divt_taskID detected.

50.16 Database error messages: error code 91xx

Error no.	Description
9100	Unidentified database error.
9101	Invalid data code.
9102	Invalid data type.
9103	Invalid source ID.
9104	Unstable data.
9105	Invalid data.
9106	No writing permission.
9107	Invalid activity.
9108	Task idle.
9109	Mailbox overflow.
9110	Invalid DB word ID.
9111	Invalid selection ID.
9112	Invalid selection value.
9113	Invalid target ID.
9114	Invalid data ID.
9115	Invalid hour.
9116	Invalid minute.
9117	Invalid second.
9118	Invalid day.
9119	Invalid month.
9120	Invalid year.
9121	Incorrect data string size.
9122	Invalid language.

50.16 Database error messages: error code 91xx (cont'd.)

Error no.	Description
9123	Invalid data string ID.
9124-9126	Semaphore error.
9127	Invalid alarm code.
9128	Invalid data.
9129	Invalid data code 1.
9130	Invalid data code 2.
9131	Invalid data type.
9132	Invalid data type 2.
9133	Data 1 invalid.
9134	Data 2 invalid.
9135	Invalid data section.
9136	Invalid attribute.
9137	ASCII4 RAM NOVRAM inconsistency corrected.

50.17 Other errors: error code 92xx. Hardware errors

Error no.	Description
9200	5 V voltage value is too low (<4.7 V). Power supply unit?
9201	Internal hardware temperature is too high. Fan? Fan mat? 12 V supply?
9202	NTC does not function.
9203	Anesthetic vaporizer "Vapor 19.n" cannot be identified.
9204	Water level detector does not function. Connector plugged in?
9205	Exit Service Mode from standby. Up to SW 3.0 always in combination with 11252 and 11138, but also 8064 or 0014, if applicable.
9250	Time difference is too big
9251	Processor approaches load limit.

50.18 Alarm: error code 93xx

Error no.	Description
9300	Fatal error occurred.

50.18 Alarm: error code 93xx (cont'd.)

Error no.	Description
9301	Incorrect alarm priority occurred.
9302-9306	Error in alarm, processing.
9309	Illegal alarm volume found.

50.19 ROSY: error code 94xx (CIO PCB)

Error no.	Description
9400	Invalid task id received.
9401	Odd task entry address received.
9402	Odd top-of-stack address of task received.
9403	Odd mailbox address of a task received.
9404	Internal error occurred. Task control block data is faulty.
9405	Invalid mailbox id received.
9406	Mailbox overflow received.
9407	Invalid ISR id received.
9408	Multiple install of an ISR occurred.
9409	Invalid vector in the ISR description received.
9410	Invalid entry address of the ISR received.
9411	Invalid name of the ISR (= 0) received.
9412	Invalid driver id (DCB address) received.
9413	Multiple install of a driver occurred.
9414	Invalid driver address (indicator on INFOBL) received.
9415	Invalid driver name received.
9416	Driver cannot be installed.
9417	Invalid SEMA id (SCB address) received.
9418	Multiple SEMA request of a task executed.
9419	Task.
9420	Internal error occurred. SCB is defective.
9421	Invalid monitor task id received.
9422	Trap #2-15 in the monitoring mode occurred.
9423	Base for user mode exception occurred.

50.19 ROSY: error code 94xx (CIO PCB) (cont'd.)

Error no.	Description
9424	User mode: bus error 9425 occurred.
9425	User mode: address error occurred.
9426	User mode: invalid statement occurred.
9427	User mode: zero divide error occurred.
9428	User mode: CK statement error occurred.
9429	User mode: TRAPV statement error occurred.
9430	User mode: privilege violation error occurred.
9431	User mode: Line 1010 emulator error occurred.
9432	User mode: Line 1111 emulator error occurred.
9433	Trap #2-15 error occurred.
9434	Trap #1 monitoring mode is not valid.
9435	Trap #0 in the user mode is not valid.
9436	Invalid exception no. (internal error) occurred.
9437	Invalid list no. with task or driver.
9438	Invalid SVC no. from the ISR occurred.
9439	Task does not run.
9440	Task has no mailbox.
9441	Task is idle.
9442	Task is not idle.
9443	Task was not stopped.
9444	Task does not wait for I/O completion.
9445	Length of the message is incorrect.
9446	Signal overflow occurred.
9447	Parameter error: activation type is incorrect.
9448	Parameter error: cycle time is incorrect.
9449	Parameter error: event type is incorrect.
9450	Parameter error: timeout overflow.
9451	Parameter error: parameter block address is invalid.
9452	ISR description of the plausibility field is invalid.
9453	Driver description of the plausibility field is invalid.
9454	No time. Activation is available.
9455	No timeout available.

50.19 ROSY: error code 94xx (CIO PCB) (cont'd.)

Error no.	Description
9456	Exception vector array address is invalid.
9457	Odd product no. received.
9458	Error while copying the message onto the monitor task received.
9459	Internal error: ROSY68K timeout occurred.
9460-9483	Other software error.

50.20 Performance control messages: error code 948x

Error no.	Description
9480	The time difference between two activations is too big. CPU PCB or CAN PCB?
9484	Rosy: Odd bottom-of-stack address
9485	Rosy: Error of address at T2-GETN
9486	Rosy: Stack format at exception
9487	Rosy: Operating system stack or driver overflow
9488	Rosy: Stack overflow of a task

50.21 Monitor error messages: error code 95xx

Error no.	Description
9500	Unexpected message received.
9501	Task abort message received. Maximum processor capacity reached. If applicable, replace CPU PCB, CAN PCB. Parabox not connected?
9503	Incorrect system time.
9504	Debug mode selected.
9505	Moni: Exception abort message

50.22 Printer error messages: error code 96xx

Error no.	Description
9600-9637	Contact DW Lübeck if no hardware error has occurred.
9638	Cold start or warm start after powerfail. Batteries are flat or defective. DC converter is defective.

50.22 Printer error messages: error code 96xx (cont'd.)

Error no.	Description
9639	Reset in self test. May be entered after a reset in the extended service mode. Up to and including SW 2.02, a reset can be triggered after starting the service mode.
9640	Warm start after user switch-off

50.23 Medibus error messages: error code 97xx

Error no.	Description
9700-9711	Contact DW Lübeck.
9904	Medibus error. Is also entered if an existing Medibus connection is interrupted or baud rates are different.

50.24 CIO PCB hardware messages: error code 10000-10499

Error no.	Description
10000-10499	Contact DW Lübeck (dual port RAM on CAN PCB defective?).

50.25 CIO PCB software messages: error code 10500-10999

Error no.	Description
10500	Overflow in one queue.
10502	Unavailable queue selected.
10503	One queue is busy longer than the maximum time.
10601-16086	Possible contact problems on CAN connections.
10800	Receive FIFO on the CAN PCB. Data loss possible.
10801	CRX: error occurred while receiving or transmitting data.
10802	Error from external equipment or error during transmission not detected.
10803	CAN PCB communication problem, cable, terminal resistor?
10804	Communication problem, old software?
10805	Same as 10803
10806	CAN controller error during logon occurred. Hardware is defective.
10807	Internal format error in setting intention occurred.

50.25 CIO PCB software messages: error code 10500-10999 (cont'd.)

Error no.	Description
10808	The database on the CAN PCB contained no correct setting intention.
10809	The setting intention was converted into an invalid data type.
10810	Internal format error during Notify/Reply occurred.
10811	Error during reading the CAN PCB database into dNotify/dReply occurred.
10812	This database type cannot be sent as Reply/Notify on CAN.
10813	Incorrect data type in the event/status message sent.
10814	Unknown VICABUS error type sent.
10815	BCAN error after logon occurred. Cable, CAN PCB, terminal resistor.
10816	BCAN error after logon occurred. Cable, CAN PCB, terminal resistor.
10817-10823	Error in transport function.

50.26 Vent/EDOS (ventilator, electronic flow control): Error code 11000 - 11499 (Ventdos-Controller PCB and Actuator PCB)

Error no. **Description** **Reaction**

Errors displayed on-line and the corresponding reaction from Vent/EDOS:

If, for example, Ws and S appear in the reaction column, a warm start is initiated first. If the same error occurs again within 10 minutes, Julian switches to safety mode.

Abbreviations:
kM = no message; nM = message only;
WR = warm start request; rC = reset CAN; Ws = warm start;
Cs = cold start
nV = no ventilation;
rS = reset SABUS; S = safety;
e = this error code is not applicable
MOBi = human interface (CIO PCB);
ComPro = microcontroller on Front PCB;
SABUS = protocol on the CAN bus;
SV = supervisor; MA = master;
INIMODE = status after reset;
POST = power-on self-test

Error no.	Description	Reaction
11000	No error.	nM

50.26 Vent/EDOS (ventilator, electronic flow control): Error code 11000 - 11499 (Ventdos-Controller PCB and Actuator PCB) (cont'd.)

Error no.	Description	Reaction
11001-11100	If a self-test fails, 11000 + the test-step number is displayed (for example, if the error occurs during the self-test in test step 35: 11035 is displayed).	
11099	As of SW 3.0: self-test completed successfully.	nM
11101	Faulty inspiration flow (high pressure > 2300 mbar)	Ws, (nV)
	Reaction as of SW 3.0	Ws, S
11102	As of SW 3.0: PEEP cannot be adjusted.	nM
11103	As of SW 3.0: Faulty PEEP valve.	Ws, S
11104	As of SW 3.0: Faulty ventilator parameters for more than 10 s.	Ws, S
11105	As of SW 3.0: Mixer O2 valve stuck in open position.	Ws, S
11106	As of SW 3.0: Mixer AIR valve stuck in open position.	Ws, S
11107	As of SW 3.0: Mixer N2O valve stuck in open position.	Ws, S
11108	As of SW 3.0: O2 flow in mixing container is too low.	nM
11109	As of SW 3.0: AIR flow in mixing container is too low.	nM
11110	As of SW 3.0: N2O flow in mixing container is too low.	nM
11111	As of SW 3.0: Flow measurement in mixing container is faulty.	Ws, S
11112	As of SW 3.0: Mixed gas flow is incorrect.	Ws, S
11115	The two-channel consistent data before and after a warm start of the MOBi differ.	S
	As of SW 3.n the error code is in connection with a safety condition and error codes 11115 + 11116 (see chapter 47.1)	
11116	SABUS channel 12 and 13 data are not consistent for 5 seconds. The CAN communication between Front PCB, CIO PCB, and Ventdos-Controller PCB is faulty.	nM, WR
	As of SW 3.n the error code is in connection with a safety condition and error codes 11116 + 11115 (see chapter 47.1)	
11117	No constant data available on SABUS channels 12 and 13 for 30 seconds. The CAN communication between Front PCB, CIO PCB, and Ventdos-Controller PCB is faulty.	S

50.26 Vent/EDOS (ventilator, electronic flow control): Error code 11000 - 11499 (Ventdos-Controller PCB and Actuator PCB) (cont'd.)

Error no.	Description	Reaction
11118	No data received from MOBi via SABUS channel 13 for 30 seconds. The CAN communication between CIO PCB and Ventdos-Controller PCB is faulty.	S
11119	No data received from ComPro via SABUS channel 12 for 30 seconds. The CAN communication between Front PCB and Ventdos-Controller PCB is faulty.	S
11120	No data transmitted via SABUS channel 13 for 30 seconds. The CAN communication between CIO PCB and Ventdos-Controller PCB is faulty.	S
11121	No data from SV (supervisor) received on channel 11 for 6 seconds (Reaction kM and rS only during INIMODE, POST, SERVICE. Reaction nM only during NORMAL and similar). Communication between the master and the supervisor on Ventdos-Controller PCB is faulty.	kM, rS, nM
11122	No data received from SV on channel 11 for 30 seconds. Communication between the master and the supervisor on Ventdos-Controller PCB is faulty.	S
11123	SV reports that the A-cone is in the wrong position.	nM
	The A-cone is in the wrong position.	kM
	SV reports that the fan is not turning. (Up to SW 1.n)	nM
11125	SABUS cannot be initiated.	nM
11126	SABUS cannot be sustained.	nM
11127	Two resets were started by the SV within a 100-s period.	Ws, S
11128	No acceptable operating mode sent from the SV (possibly over a 10-s period).	S
11129	SV sends SAFETY operating mode.	S
11130	The MOBi requests unacceptable set values from more than 10 seconds.	Ws, S
11131	MOBi requests SAFETY operating mode.	S
11132	A prohibited operating mode transition detected in the MA (master).	S
11133	MOBi requests an unacceptable operating mode for more than 10 seconds.	S
11134	Too many SW errors detected in the MA in too short a period of time.	S

50.26 Vent/EDOS (ventilator, electronic flow control): Error code 11000 - 11499 (Ventdos-Controller PCB and Actuator PCB) (cont'd.)

Error no.	Description	Reaction
11135	Battery error MA	kM
11136	SV has triggered a reset	Ws
11137	No data received from MOBi or ComPro for 20 seconds.	nM, rS
	Reaction as of SW 3.0:	e
11138	No data received from MOBi or ComPro for 10 seconds.	nM, rC
	Reaction as of SW 3.0:	e
11139	No data received from SV on channel 11 for 20 seconds.	nM, rS
11140	No data received from SV on channel 11 for 10 seconds.	nM, rC
	Reaction as of SW 3.0:	e
11141	CAN-HW has reception problems (will be suppressed for max. 10 seconds in the event of an error).	nM, rC
11142	MA and SV detect status of SAFETY flow control valve differently.	nM
11143	Light barrier of fresh-gas shortage detection is defective or detects parasitic light.	Ws, (nV) S
11144	As of SW 3.0: The fresh-gas shortage detection hardware (light barrier) is defective or detects stray light.	nM
11145	As of SW 3.0: ComPro transmits other mode than "OPmode sb12_Normal" for 5 s (ComPro is only allowed to be in normal mode)	nM, WR
11146	As of SW 3.0: No data available from the most recent "MOBi. Warm-Dropped" to compare with current "MOBi data".	nM
11147	As of SW 3.0: The length of a message to be sent to SABUS channel 13 or 11 was found to be too long. (> 112 bytes)	Ws
11201	Position of driving flow valve (light barrier detector) is faulty or makes no sense.	Ws, (nV) S
11202	Ventilator block error, frequency SV. Evaluation of MV2 switching cycle.	Ws, (nV) S
11203	Ventilator block error, pressure limit SV. Paw exceeds Pmax by more than 5 mbar for more than 5 s. Patient system, PEEP valve or AGS.	Ws, (nV) S

50.26 Vent/EDOS (ventilator, electronic flow control): Error code 11000 - 11499 (Ventdos-Controller PCB and Actuator PCB) (cont'd.)

Error no.	Description	Reaction
11204	Ventilation mode error. Evaluation of feedback from MV3. Is in the wrong position.	Ws, (nV) S
11205	The measured mixed-gas flow V10 exceeds the set value by more than 30% (or 300 mL/min). Ptank decreases too fast. Leakage in EDOS block or V7 (see repair information in chapter "11.5 "EDOS Leak Test"" of the Pneumatics Repair Instructions). Flow V10 is too high.	Ws, S
11206	The measured mixed-gas flow V10 is below the set value by more than 30% (or 300 mL/min). Ptank decreases too slowly. Leakage in one of the ZV valves (see repair information in chapter "11.5 "EDOS Leak Test"" and chapter "11.4 "Blockage in EDOS Hose System"" of the Pneumatics Repair Instructions). Flow V10 is too low.	Ws, S
11207	The mixed-gas flow V10 cannot be determined for more than 5 reservoir filling cycles. Ptank decreased too fast. As in 11205.	Ws, S
11208	Incorrect O_2 concentration in the reservoir of the EDOS block. Error code not generated with software 1.04 or higher. Error codes generated with software 1.04 or higher are 11209 and 11210.	kM
	Reaction as of SW 3.0:	e
11209	The measured O_2 concentration in the reservoir of the EDOS block differs from the set value by more than +20% (or +5% points). Error may occur if wrong gases are connected, e.g. AIR instead of N2O. The different viscosity of the gases leads to incorrect mixing ratios. Mixing is done via Pmix. The increase in pressure in the reservoir is measured via Ptank. Possible error sources are Pmix, Ptank, and the centrals supply system inlet valves.	Ws, S
	Reaction as of SW 3.0:	nM
11210	The measured O_2 concentration differs from the set value by more than -20% (or -5% points). Error may occur if wrong gases are connected, e.g. AIR instead of N2O. The different viscosity of the gases leads to incorrect mixing ratios. Mixing is done via Pmix. The increase in pressure in the reservoir is measured via Ptank. Possible error sources are Pmix, Ptank, and the centrals supply system inlet valves.	Ws, S

50.26 Vent/EDOS (ventilator, electronic flow control): Error code 11000 - 11499 (Ventdos-Controller PCB and Actuator PCB) (cont'd.)

Error no.	Description	Reaction
11211	The reservoir flush valve is open longer than 3 seconds, or opened too often. The electronic valve feedback is monitored.	Ws, S
11212	Incorrect mixed-gas flow. Error code not generated with software 1.04 or higher. Error codes generated with software 1.04 or higher are 11205 and 11206.	kM
	Reaction as of SW 3.0	e
11213	The measured reservoir pressure is below 300 mbar, which corresponds to a geographical height of 10 km above sea level. Ptank faulty.	Ws, S
11214	No consistent data available on SABUS channels 12 and 13 for 30 seconds (also during INIMODE). CAN communicaton error between Front PCB, CIO PCB and Ventdos-Controller PCB.	S
11215	No data received from ComPro via SABUS channel 12 for 30 seconds. CAN communicaton error between Front PCB and Ventdos-Controller PCB.	S
11216	No data received from MOBi via SABUS channel 13 for 30 seconds. CAN communicaton error between CIO PCB and Ventdos-Controller PCB.	S
11217	No data could be transmitted via SABUS channel 13 for 30 seconds. CAN communicaton error between CIO PCB and Ventdos-Controller PCB.	S
	Reaction as of SW 3:0	e
11218	No data received from MA via channel 11 for 30 seconds. CAN communicaton error between master and supervisor on Ventdos-Controller PCB.	S
11219	No data could be transmitted via SABUS channel 11 for 30 seconds. CAN communicaton error between master and supervisor on Ventdos-Controller PCB.	S
11220	The A-cone is in the wrong position. Check valve feedback in service mode.	nM
11221	ADC conversion error on Ventdos-Controller PCB.	Ws, S
11222	The operating voltages are outside their individual tolerances. Check operating voltages in service mode. DC converter is probably defective.	Ws, S
	Reaction as of SW 3.0:	e

50.26 Vent/EDOS (ventilator, electronic flow control): Error code 11000 - 11499 (Ventdos-Controller PCB and Actuator PCB) (cont'd.)

Error no.	Description	Reaction
11223	The fan is not turning.	nM
11224	SABUS cannot be initiated. CAN communication between Front PCB, CIO PCB, SLIO PCB, and Ventdos-Controller PCB.	nM
11225	SABUS cannot be sustained. CAN communication between Front PCB, CIO PCB, SLIO PCB, and Ventdos-Controller PCB.	nM
11226	MA triggered more than 2 resets within 100 seconds. 11235 must have been entered first. Ventdos-Controller PCB, DC converter.	Ws, S
11227	MA transmits no acceptable operating modes for 10 seconds.	S
11228	MA transmits SAFETY operating mode.	S
11229	The MOBi requests unacceptable set values for more than 10 seconds.	Ws, S
11230	MOBi requests SAFETY operating mode.	S
11231	A prohibited operating mode transition detected in the SV.	S
11232	MOBi requests an unacceptable operating mode for more than 10 seconds.	S
11234	Different HW and CAN information about the mains switch status. Normal after config reset, software download, battery replacement, total failures due to voltage supply failures, and resets.	nM
11235	MA has triggered a reset.	Ws
11236	As of SW 3.0: The length of a message to be sent to SABUS channel 11 was found to be too long (>112 bytes).	Ws
11237	A SABUS message received incorrectly (will be suppressed for max. 10 seconds in the event of an error).	nM, rC
11238	As of SW 3.0: ADC conversion error	Ws, S
11239	As of SW 3.0: 5V supply voltage is outside tolerance.	nM
11240	SV has problems with gas shortage information from MA.	nM
11241	No gas shortage information received from MA during the last 5 subsequent reservoir filling cycles. SV continues working with the last received gas shortage information.	nM

50.26 Vent/EDOS (ventilator, electronic flow control): Error code 11000 - 11499 (Ventdos-Controller PCB and Actuator PCB) (cont'd.)

Error no.	Description	Reaction
11242	MA signals an O2 shortage, but SV measures a sufficient inlet flow (> 26.4 L/min) via the O2 valve. SV uses only the information from the MA for its performance.	nM
11243	MA signals an AIR shortage, but SV measures a sufficient inlet flow (> 26.4 L/min) via the AIR valve. SV uses only the information from the MA for its performance.	nM
11244	MA signals an N2O shortage, but SV measures a sufficient inlet flow (> 26.4 L/min) via the N2O valve. SV uses only the information from the MA for its performance.	nM
11245	MA signals no O2 shortage, but the SV measures a considerably lower inlet flow (<= 14 L/min) via the O2 valve. SV uses only the information from the MA for its performance.	nM
11246	MA signals no AIR shortage, but the SV measures a considerably lower inlet flow (<= 14 L/min) via the AIR valve. SV uses only the information from the MA for its performance.	nM
11247	MA signals no N2O shortage, but the SV measures a considerably lower inlet flow (<= 14 L/min) via the N2O valve. SV uses only the information from the MA for its performance.	nM
11248	Mixer valves are open for too long (1.5 seconds)	nM
11249	The measured reservoir pressure exceeds 2.5 bar absolute.	nM
11250	More than 1 mixer valve open.	nM
11251	No data received from MOBi or ComPro for 20 seconds. CAN communication between CIO PCB, Front PCB, and Ventdos-Controller PCB.	nM, rS
	Reaction as of SW 3.0:	e
11252	No data received from MOBi or ComPro for 10 seconds. CAN communication between CIO PCB, Front PCB, and Ventdos-Controller PCB.	nM, rC
	As of SW 3.0:	e
11253	No data received from MA on channel 11 for 20 seconds. CAN communication between master and supervisor on the Ventdos-Controller PCB.	nM, rS

50.26 Vent/EDOS (ventilator, electronic flow control): Error code 11000 - 11499 (Ventdos-Controller PCB and Actuator PCB) (cont'd.)

Error no.	Description	Reaction
11254	No data received from MA on channel 11 for 10 seconds. CAN communication between master and supervisor on the Ventdos-Controller PCB	nM, rC
	Reaction as of SW 3.0:	e
11255	The ventilatory flow is too high (evaluation of error suppressed for the time being).	kM
11256	The ventilatory flow is too low (evaluation of error suppressed for the time being).	Ws, (nV) S
11257	MOBi requests non-adjustable ventilatory flow for 10 seconds.	Ws, (nV) S
11258	SV and MA detect status of SAFETY flow control valve differently.	nM
11259	As of 3.0: The +15V supply voltage is below the tolerance limit.	Ws, S
11260	As of 3.0: The +24V supply voltage is below the tolerance limit.	Ws, S
11261	As of 3.0: The -15V supply voltage is below the tolerance limit.	kM
11262	As of 3.0: The 30V span of the supply voltage is below the tolerance limit.	Ws, S
11263	As of 3.0: The +5V supply voltage is above the tolerance limit.	Ws, S
11264	As of 3.0: The +15V supply voltage is above the tolerance limit.	Ws, S
11265	As of 3.0: The +24V supply voltage is above the tolerance limit.	Ws, S
11266	As of 3.0: The -15V supply voltage is above the tolerance limit.	kM
11267	As of 3.0: The 30V span of the supply voltage is above the tolerance limit.	Ws, S
11302, 11402	New HW/SW, monitor is in POST (power-on self-test). As of SW 3.0 this code is no longer generated.	Initial start e
11303, 11403	New HW/SW, monitor is in standby mode. As of SW 3.0 this code is no longer generated.	S e

50.26 Vent/EDOS (ventilator, electronic flow control): Error code 11000 - 11499 (Ventdos-Controller PCB and Actuator PCB) (cont'd.)

Error no.	Description	Reaction
11304, 11404	New HW/SW, monitor is in normal mode (IPPV, MAN/SPONT or PCB). As of SW 3.0 this code is no longer generated.	S e
11305, 11405	New HW/SW, monitor is in safety mode. As of SW 3.0 this code is no longer generated.	S e
11306, 11406	New HW/SW, monitor is in service mode. As of SW 3.0: external RAM data corrupt, monitor transmits IniMode.	Service mode -Cold start
11307, 11407	Up to SW 2.02: not assigned. As of SW 3.0: external RAM data corrupt, monitor transmits POST.	- -Cold start
11308, 11408	External RAM battery is flat, monitor is in POST. As of SW 3.0: external RAM data corrupt, monitor transmits IniMode -> POST.	Initial start Cold start
11309, 11409	External RAM battery is flat, monitor is in standby mode. As of SW 3.0: external RAM data corrupt, monitor transmits Standby.	S Ws
11310, 11410	External RAM battery is flat, monitor is in normal mode (IPPV, MAN/SPONT or PCB). As of SW 3.0: external RAM data corrupt, monitor Normal.	S Ws
11311, 11411	External RAM battery is flat, monitor is in safety mode. As of SW 3.0: external RAM data corrupt, monitor transmits Safety.	S S
11312, 11412	External RAM battery is flat, monitor is in service mode.	Service mode
11313, 11413	Reset due to power switch ON/OFF, monitor is in standby mode.	S
11314, 11414	Reset due to power switch ON/OFF, monitor is in normal mode (IPPV, MAN/SPONT or PCV).	S
11315, 11415	Reset due to power switch ON/OFF, monitor is in safety mode.	S
11316, 11416	Reset due to power switch ON/OFF, monitor is in service mode.	Service mode
11317, 11417	Reset due to watchdog test, monitor is in standby mode.	S

50.26 Vent/EDOS (ventilator, electronic flow control): Error code 11000 - 11499 (Ventdos-Controller PCB and Actuator PCB) (cont'd.)

Error no.	Description	Reaction
11318, 11418	Reset due to watchdog test, monitor is in normal mode (IPPV, MAN/SPONT or PCV).	S
11319, 11419	Reset due to watchdog test, monitor is in safety mode.	S
11320, 11420	Reset due to watchdog test, monitor is in service mode.	Service mode
11321, 11421	Reset due to OSC watchdog, Vent/EDOS was in IniMode prior to reset.	S
11322, 11422	Reset due to OSC watchdog, Vent/EDOS was in self test prior to reset.	S
11323, 11423	Reset due to OSC watchdog, Vent/EDOS was in standby prior to reset, monitor is in self test after reset.	S
11324, 11424	Reset due to OSC watchdog, Vent/EDOS was in standby prior to reset, monitor is in standby after reset.	Ws
11325, 11425	Reset due to OSC watchdog, Vent/EDOS was in standby prior to reset, monitor is in normal mode after reset.	Ws
11326, 11426	Reset due to OSC watchdog, Vent/EDOS was in standby prior to reset, monitor is in safety mode after reset.	S
11327, 11427	Reset due to OSC watchdog, Vent/EDOS was in standby prior to reset, monitor is in service mode after reset.	S
11328, 11428	Reset due to OSC watchdog, Vent/EDOS was in normal mode prior to reset, monitor is in self test after reset.	S
11329, 11429	Reset due to OSC watchdog, Vent/EDOS was in normal mode prior to reset, monitor is in standby after reset.	Ws
11330, 11430	Reset due to OSC watchdog, Vent/EDOS was in normal mode prior to reset, monitor is in normal mode after reset.	Ws
11331, 11431	Reset due to OSC watchdog, Vent/EDOS was in normal mode prior to reset, monitor is in safety mode after reset.	S
11332, 11432	Reset due to OSC watchdog, Vent/EDOS was in normal mode prior to reset, monitor is in service mode after reset.	S
11333, 11433	Reset due to OSC watchdog, Vent/EDOS was in safety mode prior to reset.	S
11334, 11434	Reset due to OSC watchdog, Vent/EDOS was in service mode prior to reset, monitor is in self test after reset.	S

50.26 Vent/EDOS (ventilator, electronic flow control): Error code 11000 - 11499 (Ventdos-Controller PCB and Actuator PCB) (cont'd.)

Error no.	Description	Reaction
11335, 11435	Reset due to OSC watchdog, Vent/EDOS was in service mode prior to reset, monitor is in standby after reset.	S
11336, 11436	Reset due to OSC watchdog, Vent/EDOS was in service mode prior to reset, monitor is in normal mode after reset.	S
11337, 11437	Reset due to OSC watchdog, Vent/EDOS was in service mode prior to reset, monitor is in safety mode after reset.	S
11338, 11438	Reset due to OSC watchdog, Vent/EDOS was in service mode prior to reset, monitor is in service mode after reset.	Service mode
11339, 11439	Reset due to Int watchdog, Vent/EDOS was in IniMode prior to reset.	S
11340, 11440	Reset due to Int watchdog,Vent/EDOS was in self test prior to reset.	S
11341, 11441	Reset due to Int watchdog, Vent/EDOS was in standby mode prior to reset, monitor is in self test after reset.	S
11342, 11442	Reset due to Int watchdog, Vent/EDOS was in standby mode prior to reset, monitor is in standby mode after reset.	Ws
11343, 11443	Reset due to Int watchdog, Vent/EDOS was in standby mode prior to reset, monitor is in normal mode after reset.	Ws
11344, 11444	Reset due to Int watchdog, Vent/EDOS was in standby mode prior to reset, monitor is in safety mode after reset.	S
11345, 11445	Reset due to Int watchdog, Vent/EDOS was in standby prior to reset, monitor is in service mode after reset.	S
11346, 11446	Reset due to Int watchdog, Vent/EDOS was in normal mode prior to reset, monitor is in self test after reset.	S
11347, 11447	Reset due to Int watchdog, Vent/EDOS was in normal mode prior to reset, monitor is in standby mode after reset.	Ws
11348, 11448	Reset due to Int watchdog, Vent/EDOS was in normal mode prior to reset, monitor is in normal mode after reset.	Ws
11349, 11449	Reset due to Int watchdog, Vent/EDOS was in normal mode prior to reset, monitor is in safety mode after reset.	S
11350, 11450	Reset due to Int watchdog, Vent/EDOS was in normal mode prior to reset, monitor is in service mode after reset.	S
11351, 11451	Reset due to Int watchdog, Vent/EDOS was in safety mode prior to reset.	S

50.26 Vent/EDOS (ventilator, electronic flow control): Error code 11000 - 11499 (Ventdos-Controller PCB and Actuator PCB) (cont'd.)

Error no.	Description	Reaction
11352, 11452	Reset due to Int watchdog, Vent/EDOS was in service mode prior to reset, monitor is in self test after reset.	S
11353, 11453	Reset due to Int watchdog, Vent/EDOS was in service mode prior to reset, monitor is in standby mode after reset.	S
11354, 11454	Reset due to Int watchdog, Vent/EDOS was in service mode prior to reset, monitor is in normal mode after reset.	S
11355, 11455	Reset due to Int watchdog, Vent/EDOS was in service mode prior to reset, monitor is in safety mode after reset.	S
11356, 11456	Reset due to Int watchdog, Vent/EDOS was in service mode prior to reset, monitor is in service mode after reset.	Service mode
11357, 11457	Unknown reset, Vent/EDOS was in IniMode mode prior to reset.	S
11358, 11458	Unknown reset, Vent/EDOS was in self test mode prior to reset.	S
11359, 11459	Unknown reset, Vent/EDOS was in standby mode prior to reset, monitor is in self test after reset.	S
11360, 11460	Unknown reset, Vent/EDOS was in standby mode prior to reset, monitor is in standby mode after reset. Can be entered in standby in the event of an operating voltage failure.	Ws
11361, 11461	Unknown reset, Vent/EDOS was in standby mode prior to reset, monitor is in normal mode after reset.	Ws
11362, 11462	Unknown reset, Vent/EDOS was in standby mode prior to reset, monitor is in safety mode after reset.	S
11363, 11463	Unknown reset, Vent/EDOS was in standby mode prior to reset, monitor is in service mode after reset.	S
11364, 11464	Unknown reset, Vent/EDOS was in normal mode prior to reset, monitor is in self test after reset.	S
11365, 11465	Unknown reset, Vent/EDOS was in normal mode prior to reset, monitor is in standby mode after reset.	Ws
11366, 11466	Unknown reset, Vent/EDOS was in normal mode prior to reset, monitor is in normal mode after reset. Can be entered in normal mode in the event of an operating voltage failure.	Ws
11367, 11467	Unknown reset, Vent/EDOS was in normal mode prior to reset, monitor is in safety mode after reset.	S

50.26 Vent/EDOS (ventilator, electronic flow control): Error code 11000 - 11499 (Ventdos-Controller PCB and Actuator PCB) (cont'd.)

Error no.	Description	Reaction
11368, 11468	Unknown reset, Vent/EDOS was in normal mode prior to reset, monitor is in service mode after reset.	S
11369, 11469	Unknown reset, Vent/EDOS was in safety mode prior to reset. Can be entered in safety mode in the event of an operating voltage failure.	S
11370, 11470	Unknown reset, Vent/EDOS was in service mode prior to reset, monitor is in self test after reset.	S
11371, 11471	Unknown reset, Vent/EDOS was in service mode prior to reset, monitor is in self test after reset.	S
11372, 11472	Unknown reset, Vent/EDOS was in service mode prior to reset, monitor is in standby after reset.	S
11373, 11473	Unknown reset, Vent/EDOS was in service mode prior to reset, monitor is in normal mode after reset.	S
11374, 11474	Unknown reset, Vent/EDOS was in service mode prior to reset, monitor is in service mode after reset.	Service mode
11376, 11476	As of SW 3.n: Reset due to OSC watchdog, incorrect OP mode prior to reset.	S
11377, 11477	As of SW 3.n: Unknown reset, Vent/EDOS was in standby prior to reset, monitor is in service mode after reset.	S
11378, 11478	As of SW 3.n: "Unknown" reset, incorrect OP mode prior to reset safety.	S
11381, 11481	As of SW 3.n: POST log initiliazed because of corrupt data in ext. RAM; reset due to power switch off/on, monitor transmits IniMode.	Cs
11382, 11482	As of SW 3.n: POST log initiliazed because of corrupt data in ext. RAM; reset due to power switch off/on, monitor transmits POST.	Cs
11383, 11483	As of SW 3.n: POST log initiliazed because of corrupt data in ext. RAM; reset due to power switch off/on, monitor transmits IniMode->POST.	Cs
11384, 11484	As of SW 3.n: POST log initiliazed because of corrupt data in ext. RAM; reset due to power switch off/on, monitor transmits standby.	Cs
11385, 11485	As of SW 3.n: POST log initiliazed because of corrupt data in ext. RAM; reset due to power switch off/on, monitor transmits normal mode.	Cs

50.26 Vent/EDOS (ventilator, electronic flow control): Error code 11000 - 11499 (Ventdos-Controller PCB and Actuator PCB) (cont'd.)

Error no.	Description	Reaction
11386, 11486	As of SW 3.n: POST log initiliazed because of corrupt data in ext. RAM; reset due to power switch off/on, monitor transmits safety mode.	S
11387, 11487	As of SW 3.n: POST log initiliazed because of corrupt data in ext. RAM; reset due to power switch off/on, monitor transmits service mode.	Service Mode
11388, 11488	As of SW 3.n: POST log initiliazed because of corrupt data in ext. RAM; reset due to watchdog test off/on, monitor transmits IniMode.	Cs
11389, 11489	As of SW 3.n: POST log initiliazed because of corrupt data in ext. RAM; reset due to watchdog test off/on, monitor transmits POST.	Cs
11390, 11490	As of SW 3.n: POST log initiliazed because of corrupt data in ext. RAM; reset due to watchdog test off/on, monitor transmits IniMode –>POST.	Cs
11391, 11491	As of SW 3.n: POST log initiliazed because of corrupt data in ext. RAM; reset due to watchdog test off/on, monitor transmits standby mode.	Ws
11392, 11492	As of SW 3.n: POST log initiliazed because of corrupt data in ext. RAM; reset due to watchdog test off/on, monitor transmits normal mode.	Ws
11393, 11493	As of SW 3.n: POST log initiliazed because of corrupt data in ext. RAM; reset due to watchdog test off/on, monitor transmits safety.	S
11394, 11494	As of SW 3.n: POST log initiliazed because of corrupt data in ext. RAM; reset due to watchdog test off/on, monitor transmits service mode.	Service Mode

50.27 Vent/EDOS (ventilator electronic dosage): error code 11500 - 11999

The supervisor monitors all processes of the master (both located on the Ventdos Controller PCB. Processes: ventilation, communication, etc.). When the supervisor detects an error, it triggers a reset (warm start). The reset is intended to correct possible errors in the Ventdos system.

The supervisor writes a log about all generated errors. This log is transmitted to the monitor and displayed in the error list only when the Extended Service Mode is started. Time and date do not correspond to the occurrence of the errors. It is the time when the Service Mode is started. To each error code > 11500 there is an identical code to the error < 11500, for example, 11511 corresponds to error 1 (drive flow) from the following table. At the same time, error 11101 is entered.

Error codes 11500 - 11999 do not occur any more in software version 2.02 or higher.

The error messages are coded as follows:

11000 +500 + warm start no. x 10 + frequency (maximum of 9)

Here are two examples:

Example 1:

Warm start no. 8 occurred three times.

11000 + 500 + 8 x 10 + 3 = 11583

First subtract 11500 from 11583. The result is 83. Warm start 8 occurred three times (3 is the one's place = quantity, 80 divided by 10 = 8, the error no.).

Example 2:

Warm start no. 23 occurred twice.

11000 + 500 +23 x 10 + 2 = 11732

First substract 11500 from 11732. The result is 232. Warm start 23 occurred twice (2 is one's place = quantity, 230 divided by 10 = 23, the error no.).

Error no.	Description
1	Drive flow error (ventilator).
2	Frequency error (ventilator).
3	Pressure limit error (ventilator).
4	Ventilation mode error (ventilator).
5	Mixed-gas flow is too high (+30%).
6	Mixed-gas flow is too low (-30%).
7	Mixed-gas flow cannot be determined for 5 cycles.
8	Measured O_2 concentration deviates from set value by more than +20%.

Error no.	Description (cont'd.)
9	Measured O_2 concentration deviates from set value by more than -20%.
10	Reservoir pressure is below 300 mbar, which corresponds to a height of 10 km above sea level.
11	The reservoir flush valve is open for more than 3 seconds, or opens too often.
12	More than one mixer valve open.
13	Mixer valves are open for too long (1.5 seconds).
14	The measured reservoir pressure exceeds 2.5 bar for more than 5 seconds.
15	No consistent data on SABUS channels 12 and 13 for 30 seconds.
16	No data received from ComPro via SABUS channel 13 for 30 seconds.
17	No data received from MOBi via SABUS channel 13 for 30 seconds.
18	No data transmitted via SABUS channel 13 for 30 seconds.
19	No data received from MA via channel 11 for 30 seconds.
20	No data transmitted via SABUS channel 11 for 30 seconds.
21	A-cone valve is in the wrong position.
22	ADC conversion error.
23	Operating voltages are outside tolerances.
24	Fan is not turning.
25	SABUS cannot be established; 82C200 cannot be initialized.
26	SABUS cannot be maintained; 82C200 continuously resetting or bus is off.
27	MA triggered more than two resets in 100 seconds.
28	MA triggered a reset.
29	MA continuously sending an unacceptable operating mode for 10 seconds.
30	MA sends operating mode Safety.
31	MOBi continuously requesting non-implementable set values for more than 10 seconds.
32	MOBi requests operating mode Safety.
33	Prohibited operating mode transition detected in the SV.
34	MOBi continuously requesting an unacceptable operating mode for more than 10 seconds.
35	Too many software errors detected in the SV within too short a period of time.
36	Different hardware and CAN information about mains switch status.

Error no.	Description (cont'd.)
37	CAN hardware has reception problems.
38	No data received from MOBi or ComPro for 20 seconds.
39	No data received from MOBi or ComPro for 10 seconds.
40	SV has problems with gas shortage information from MA.
48	No data received from MA on channel 11 for 20 seconds.
49	No data received from MA on channel 11 for 10 seconds.

50.28 SABUS: error code 12000-12019

Error	Description
12000	Could not boot SABUS software.
12001	Could not start BCAN.
12002	BCAN has gone to BUS OFF.
12003	RX queue overflow.
12004	CAN chip Rcv overflow occurred.
12005	Error interrupt occurred.

50.29 Vent/EDOS error entered by MOBi: error code 12020-12049

Error	Description
12020	Could not open SABUS channel.
12021	Could not send SABUS message.CAN bus
12022	Tag error detected.
12023	Vent/EDOS initiated a warm start.
12024	Wrong Vent/EDOS operating mode received.
12025	No new data to Vent/EDOS for a long time.
12026	Invalid MOBI operating mode.
12027	Invalid setting value detected while reading out from DB.
12028	Not possible to process Vent/EDOS data for a long time.
12029	Inconsistent data: warm start request from Vent/EDOS.
12030	Either header version or software version of Vent/EDOS does not match with MOBI.
12031	Could not request a message via communication handler.

50.29 Vent/EDOS error entered by MOBi: error code 12020-12049

Error	Description
12032	Vent/EDOS is in safety mode.
12033	Vent/EDOS is in safety mode (no communication for a long time).
12034	Master software version does not match CIO
12035	Supervisor software version does not match CIO

50.30 POWOBS TASK: error code 12100-12149

Error	Description
12100	Could not open SABUS SLIO channel.
12101	Could not send SABUS tgm to SLIO.
12102	No response from power supply SLIO. KOMMPRO present?
12103	DC converter voltage off tolerance. -> Check voltage or replace DC converter.
12104	Battery charge current insufficient. -> If power supply unit < Ver05, then switch "off" battery recognition from submenu "other" in service mode 2. -> Fuse is defective, battery is with high impedance.
12105	High temperature in DC converter. -> Filter mat? Check fan . -> Temperature sensor is defective.

50.31 History UPDATE TASK: error code 13000-13010

Error	Description
13000	Overflow of history buffer.
13001	Wrong size while reading buffer.
13002	Buffer directory failure.
13003	Buffer write failure.

50.32 QSPI and supported devices: error code 13050-13070

Error	Description
13050	qspi channel overflow.
13051	qspi task error.

50.32 QSPI and supported devices: error code 13050-13070 (cont'd.)

Error	Description
13052	qspi driver error.
13053	qspi driver abort error
13054	Unknown job assigned to QSPI.
13055	Rosy clk not updated yet.
13056	Rosy clk negative.
13057	RTC corrupted.
13058	Analog driver: abnormal termination.
13059	Analog driver: normal termination.
13060	Analog driver: database is illegal.
13061	Time management failure.

51 Errors in Service Mode Menu 2

In Service Mode menu 2, errors detected during the self test are displayed. This is intended as additional information and error description.

CIO PCB	
Message	**Faulty components**
CPU_MFP	Multi-function module initialization.
CPU_MFP1	Multi-function module interrupt.
CPU_RAM	RAM checksum.
CPU_ROM	ROM checksum.
CPU_TKRAM_CLOCK	Hardware clock.
CPU_TKRAM_TEST	TKRAM contents.
CPU_WDOG	Watchdog error.
CPU_CLOCK	CPU clock or multi-functional processor clock is incorrect.
CPU_AIR_INIT	Measured Value PCB not initialized.
CPU_AIR_TIMEOUT	Measured Value PCB does not respond.
CPU_DPR_AVAILABLE	Dual port RAM available?
CPU_DPR_TEST	Dual port RAM is defective.
CPU_TKRAM_BATTFAIL	TKRAM battery.
CPU_BUS_ERROR_LOGIC	Bus error.
CPU_SERIAL_NUMBER	D31.
CPU_FLASH_POWER	Flash EPROMS not available?

Measured Value PCB	
Message	**Faulty components**
AIR_CLOCK	Faulty quartz module (it should be 12 MHz)
AIR_TDTEST_CH1	Teledyne test
AIR_ROMTST	ROM
AIR_RAMTST	RAM
AIR_DPRTST	Dual port RAM
AIR_PIOTST	PIO
AIR_CTCTST	CTC
AIR_WDTST	Watchdog
AIR_FLOWDATTST	
AIR_FLOWREGTST	
AIR_5VTST	±5 V analog
AIR_15VTST	±15 V
AIR_VREFTST	Vref

CIO PCB		
Message	**Faulty components**	
IO_BAK0	RS232 channel 1	Communication register
IO_BAK1	2	
IO_BB0	3	
IO_BB1	4	
IO_BC0	5	
IO_BC1	6	
IO_BD0	7	
IO_BD1	8	

CIO PCB (cont'd.)		
Message	**Faulty components**	
IO_UARTREG	UART register	
IO_UARTIRQ	UART interrupt	
IO_HBB0	RS 232 channel 3	Handshake error
IO_HBB1	4	
IO_HBC0	5	
IO_HBC1	6	
IO_HBD0	7	
IO_HBD1	8	
IO_PORTIN	Input port available?	
IO_PORTOUT	Output port available?	
IO_TEMPSENSOR	Temperature sensor.	
IO_VOLTAGE	Voltage monitoring.	
IO_AVAILABLE	I/O PCB available?	
IO_WATERTRAP	Water trap, water level detector not available.	

Front PCB		
Message	**Faulty components**	
FRONT_BUS	Graphics processor.	Bus test.
FRONT_GSPINIT		Initialization.
FRONT_GSPRAMLO		Refresh memory.
FRONT_GSPRAMHI		Program memory.
FRONT_GSPADRLO		Lower address bus.
FRONT_GSPADRHI		Top address bus.
FRONT_GSPI		Interrupt.
FRONT_GSPCOMMS		Interrupt message.
FRONT_SOUNDREG	Soundchip.	

Front PCB (cont'd.)		
Message	**Faulty components**	
FRONT_KEYBD	Keys.	
FRONT_KNOB	Control knob.	
FRONT_SPKR	Loudspeaker.	
FRONT_LED	LED control.	
FRONT_AVAILABLE	Front PCB available?	
FRONT_GSPWSTRT	Error while loading the application.	
FRONT_GSPGRAPH	Test pattern is incorrect.	

CIO PCB	
Message	**Faulty components**
CAN_DPR_AVAILABLE	Dual port RAM available?
CAN_DPR_VERSION	EPROM version.
CAN_RAM	RAM.
CAN_ROM	ROM.
CAN_WDOG	Watchdog.
CAN_DPR_RAM_TEST	Dual port RAM.
CAN_DPR_IRQ	Dual port RAM interrupt.
CAN_IRQ_LOGIC	Interrupt.
CAN_BUS_ERROR	Bus error.
CAN_SERIAL_NUMBER	D39.
CAN_FLASH_POWER	Flash EPROMS not installed?
CAN_NET	
CAN_NET_IRQ	Interrupt.
CAN_ARC_NET	ARC-NET controller not installed (normal)?

CIO PCB (cont'd.)	
Message	**Faulty components**
CAN_ARC_NET_IRQ	ARC-NET interrupt (normal)?
CAN_ACIA_RS232	D38.
CAN_ACIA:IO	Register.
CAN_ACIA_IRQ	Interrupt.

52 Pneumatics Error Codes

Contents

53 Introduction to Error Code

The error code list consists of the master processor (MA) error codes and the supervisor processor (SV) error codes.

Errors are displayed on the monitor during the self-test. The error code is represented in decimal format (per underlined digit).

Julian displays the test numbers (test nos.) for the self-test. If an error occurs, find the respective test number in the list and check whether it is a master processor (MA) error or a supervisor processor (SV) error.

Example 1:Test no. 01

MA:___ 1 ___ __ SV:___ ___ ___ ___

Find the respective error (error no.) in the error list of the master processor (MA).

Section of the error list:

Test no. 01 (MA): ROM

MA error code

Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 1 0 0	1) - 2) Error in bank 0 3) -	Electronics is defective

Example 2:Test no. 01

MA:___ 1 7 ___SV:___ __ ___ __

Section of the error list:

Test no. 01 (MA): ROM

MA error code

Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 1 7 0	1) - 2) Error in bank 7 3) -	Electronics is defective

The procedure for an SV error is the same as for an MA error.

Only one error code is displayed at a time in the event of a failure (e.g. 1, 2, 4, 8, 16, 32, 64, 128). However, several errors may be summarized to one error code.

For example: error code 162 is displayed.

Example:Test no. 01

MA:___ ___ ___ 162SV:___ ___ ___ __

Conversion table (power to the base of 2) of the displayed error sum.

$2^0 = 1$
$2^1 = 2$
$2^2 = 4$
$2^3 = 8$
$2^4 = 16$
$2^5 = 32$
$2^6 = 64$
$2^7 = 128$

Sum 162

– 128 :128 is the first error from the error list
(the highest possible power to the base of 2 that can be subtracted is 2^7).

Remainder 34

– 32 : 32 is the second error from the error list

Remainder 2

− 2 : 2 is the third error from the error list

0

The highest possible power to the base of 2 that can be subtracted is 2^7 (128).

In this example, we assume that three errors have occurred (128, 32, 2).

Conventions in the error code list:

P0 = ambient pressure measured
P-Norm = 1013 mbar
P-Zero = 0 mbar

53.1 Power-On Self-Test

Power-On Self-Test			
Electronics, MA synchronization			
Test no. (display on the monitor)	Test name	Test sequence	Possible cause(s) 1) Controller 2) Abortability 3) -
00	Synchronize MA and SV MA	00	1) Only MA 2) - 3) MA delay due to switchover to SV (Ini mode -> POST)
01	ROM MA SV	03	1) MA and SV 2) Cannot be aborted 3) -
02	RAM MA SV	04	1) MA and SV 2) Cannot be aborted 3) -
03	AD converter MA SV	05	1) - 2) - 3) not applicable
04	Watchdog MA	01	1) Only MA 2) Cannot be aborted 3) Internal and external watchdog

Power-On Self-Test (continued)			
05	Watchdog SV	02	1) Only SV 2) Cannot be aborted 3) Internal and external watchdog
06	Alarm generator SV	06	1) Only SV 2) Cannot be aborted 3) -
Mixer: valves			
07	ZV3-O2 MA	17	1) Only MA 2) Cannot be aborted 3) -
08	ZV1-AIR MA	18	1) Only MA 2) Can be aborted 3) -
09	ZV2-N2O MA	19	1) Only MA 2) Can be aborted 3) -
Mixer: valves (continued)			
10	V7-tank-flush MA	- -	1) Only MA 2) - 3) No activation by POST for the time being (will be activated by Service, if necessary)
11	V10-Prop MA	35	1) - 2) - 3) Will be coded, where appropriate
12	V27 Safety (monostable) MA	38	1) Only MA 2) Can be aborted 3) -
13	V28 Safety (bistable) MA	39	1) Only MA 2) Can be aborted 3) -
Mixer: sensors, leak test			
14	P proportioning (Ptank/Psys) MA	29	1) Only MA 2) Can be aborted 3) -

Power-On Self-Test (continued)			
15	Δ-Pmix MA	09	1) Only MA 2) Cannot be aborted 3) Switchover to safety in the event of an error
16	Δ-Pfgf MA	20	1) Only MA 2) Cannot be aborted 3) -
17	Mixer leak test MA	34	1) - 2) - 3) Will be coded, where appropriate
Ventilator: valves			
18	MV1-V1-Pmax PEEP MA	36	1) Only MA 2) Can be aborted 3) -
19	MV2-V2 time control MA	- -	1) Only MA 2) - 3) No activation by POST for the time being (will be activated by Service, if necessary)
20	MV3 control gas switch MA	- -	1) - 2) - 3) May become inapplicable (see V4 Auto-ManSpont)
21	V4-Auto-Man/Spont MA	- -	1) Only MA 2) - 3) No activation by POST for the time being (will be activated by Service, if necessary)
22	MV6-A cone MA SV	24	1) Only MA 2) Can be aborted 3) -
23	PSI safety regulating valve MA	37	1) Only MA 2) Can be aborted 3) -
24	APL valve MA	26	1) Only MA 2) Can be aborted 3) -
25	RV check valve MA	- -	1) Only MA 2) - 3) Not selected for the time being

Power-On Self-Test (continued)			
26	MV5-AIR-O2 control gas MA	41	1) - 2) - 3) Not coded yet
27	F flow control (slot valve) MA	08	1) Only MA 2) Cannot be aborted 3) Switchover to safety in the event of an error
Ventilator: sensors, leak test, compliance, safety flow control valve, ...			
28	P ventilation (Paw/ Pvor/Ptank) MA SV	23	1) MA and SV 2) Can be aborted 3) -
29	Leak test during Auto ventilation mode MA	- -	1) Only MA 2) Can be aborted 3) In Software version 1.04 and higher it is an integral part of "System volume and compliance" (see test no. 32)
30	Leak test during Man/Spont ventilation mode MA	- -	1) Only MA 2) - 3) No activation by POST for the time being (will be activated by Service, if necessary)
31	Bellows leak test MA	30	1) Only MA 2) Can be aborted 3) In software version 2.00 or higher
32	System volume and compliance MA	32	1) Only MA 2) Can be aborted 3) -
33	Y-piece MA	21	1) Only MA 2) Can be aborted 3)
34	Y-piece and F flow control MA SV	22	1) Only MA 2) Can be aborted 3) In software version 2.0 or higher
35	Supply pressure control Pvor MA SV	28	1) MA and SV 2) Can be aborted 3) -
Mixer and ventilator: disconnection paths, fan			

Power-On Self-Test (continued)			
36	EDOS emergency stop MA SV	25	1) MA and SV 2) Can be aborted 3) -
37	Ventilator emergency stop MA SV	27	1) MA and SV 2) Can be aborted 3) -
38	Fan MA SV	07	1) MA and SV 2) Cannot be aborted 3) -
VentDos <--> Monitor synchronization: "current test", "mobi interaction"			
39	Synchronize VentDos with SC MA	10	1) MA 2) - 3) -
40	Test can be aborted MA	14	1) Only MA 2) - 3) For monitor display
50	Electronics test start MA	11	1) Only MA 2) - 3) For monitor display
59	Electronics test end MA	15	1) Only MA 2) - 3) For monitor display
60	Flow control test start MA	12	1) Only MA 2) - 3) For monitor display
69	Flow control test end MA	40	1) Only MA 2) - 3) For monitor display
70	Ventilator test start MA	13	1) Only MA 2) - 3) For monitor display
71	IPPV compl./ leak test start MA	31	1) Only MA 2) - 3) For monitor display
72	IPPV compl./ leak test end MA	33	1) Only MA 2) - 3) For monitor display
73	Leak test request MA	16	1) Only MA 2) - 3) "Leak test request" to monitor

Power-On Self-Test (continued)			
74	Leak test end MA	42	1) Only MA 2) - 3) For monitor display
79	Ventilator test end MA	43	1) Only MA 2) - 3) For monitor display
80	Adjust F flow control to 20 L/min MA	44	1) Only MA 2) - 3) Before standby
81	Check F flow control for 20 L/min SV	45	1) Only SV 2) Cannot be aborted 3) Before standby; switchover to Safety in the event of an error
90	POST log data to modules MA	46	1) Only MA 2) - 3) -
255	All tests completed MA	47	1) MA and SV 2) - 3) For monitor display (switchover – > standby/normal)

53.2 WarmStart Self-Test

Warm Start Self-Test			
Mixer, ventilator, VentDos <–> monitor synchronization			
Test no. (display on the monitor)	Test name	Test sequence	Possible cause(s) 1) Controller 2) Abortability 3) -
15	Pfgf-Pmix MA	01	1) Only MA 2) Cannot be aborted 3) Switchover to safety in the event of an error

Warm Start Self-Test (continued)			
27	F flow control MA	00	1) Only MA 2) Cannot be aborted 3) Switchover to safety in the event of an error
80	Adjust F flow control to 20 L/min MA	02	1) Only MA 2) - 3) Before standby; also error code for empty battery for the time being
81	Check F flow control for 20 L/min SV	03	1) Only SV 2) Cannot be aborted 3) Before standby; switchover to Safety in the event of an error
90	POST log data to modules MA	04	1) Only MA 2) - 3) -
255	All tests completed MA	05	1) MA and SV 2) - 3) For monitor display (switchover – > standby/normal)

54 Test Numbers Sorted

54.1 Test no. 00 (only MA): synchronize MA and SV

00: synchronize MA and SV		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	

00: synchronize MA and SV (continued)		
0 0 0 2	- o.k. -	

54.2 Test no. 01 (MA): ROM

01: ROM MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	

01: ROM MA error codes (continued)		
0 1 0 0	- Error in bank 0 -	Ventdos Controller PCB
0 1 1 0	- Error in bank 1 -	
0 1 2 0	- Error in bank 2 -	
0 1 3 0	- Error in bank 3 -	
0 1 4 0	- Error in bank 4 -	
0 1 5 0	- Error in bank 5 -	
0 1 6 0	- Error in bank 6 -	
0 1 7 0	- Error in bank 7 -	
0 2 0 0	- Error in the test sequence -	

54.3 Test no. 01 (SV): ROM

01: ROM SV error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	

01: ROM SV error codes (continued)		
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 1 0 0	- Error in bank 0 -	Ventdos Controller PCB
0 1 1 0	- Error in bank 1 -	
0 1 2 0	- Error in bank 2 -	
0 1 3 0	- Error in bank 3 -	
0 1 4 0	- Error in bank 4 -	
0 1 5 0	- Error in bank 5 -	
0 1 6 0	- Error in bank 6 -	
0 1 7 0	- Error in bank 7 -	
0 2 0 0	- Error in the test sequence -	

54.4 Test no. 02 (MA): RAM

02: RAM MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 0 0 4	- Error in the internal RAM -	Ventdos Controller PCB
0 0 0 8	- Error in the external RAM -	
0 0 0 16	- Error in the test sequence -	

54.5 Test no. 02 (SV): RAM

02: RAM SV error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	

02: RAM SV error codes (continued)		
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 0 0 4	- Error in the internal RAM -	Ventdos Controller PCB
0 0 0 8	- Error in the external RAM -	
0 0 0 16	- Error in the test sequence -	

54.6 Test no. 03 (MA): A/D converter

03: A/D converter MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	

54.7 Test no. 03 (SV): A/D converter

03: A/D converter SV error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	

54.8 Test no. 04 (MA): Watchdog

04: Watchdog MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	

04: Watchdog MA error codes (continued)		
0 0 0 4	- Error internal watchdog -	Ventdos Controller PCB
0 0 0 8	- Error of external watchdog -	
0 0 0 16	- Error in the test sequence -	

54.9 Test no. 05 (SV): Watchdog

05: Watchdog SV error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 0 0 4	- Error internal watchdog -	Ventdos Controller PCB
0 0 0 8	- Error of the external watchdog -	
0 0 0 16	- Error in the test sequence -	

54.10 Test no. 06 (only SV): Alarm generator (on VentDos Controller PCB)

06: Alarm generator SV error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 0 0 4	- Error (see SV) -	Buzzer or buzzer driver on Ventdos Controller PCB
0 0 0 8	- Error (see SV) -	
0 0 0 16	- Error in the test sequence -	

54.11 Test no. 07 (MA): ZV3-O2

07: ZV3-O2 MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	

07: ZV3-O2 MA error codes (continued)		
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 0 0 4	1) ZV-AIR/O2/N2O....... -> closed V7-tank-flush........... -> open V10-prop.............. -> closed (0 L/min) V27-safety .... -> closed V28-safety MV1-V1-Pmax PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas MV6-A cone F flow control 2) Ptank is not constant 3) ΔPtank > 50 mbar time-out after 10 s	Gas proportioner is defective (prerequisite) 1) ZV-AIR/O2/N2O do not close/are delayed V7-tank-flush does not open/is delayed 2) Ptank faulty? Check Ptank in service mode with open V7. Ptank indicates ambient pressure. ΔPtank must be < 50 mbar.
0 0 0 8	1) ZV-AIR/O2/N2O....... closed V7-tank-flush........... open V10-prop.............. closed (0 L/min) V27-safety............. closed V28-safety MV1-V1-Pmax PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas MV6-A cone F flow control 2) Ptank is not constant 3) ΔPtank > 60 mbar for 0.5 s	Gas proportioner is defective (prerequisite) 1) ZV-AIR/O2/N2O do not close/are delayed V7-tank-flush does not open/is delayed 2) Ptank faulty? Check Ptank in service mode with open V7. Ptank indicates ambient pressure. ΔPtank must be < 60 mbar.

07: ZV3-O2 MA error codes (continued)		
0 0 0 16	ZV-AIR/O2/N2O .... closed V7-tank-flush open...... --> closed V10-Prop .... closed .... (0 L/min) V27-safety............. closed V28-safety MV1-V1-Pmax PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas MV6-A cone F flow control 2) Ptank is not constant 3) ΔPtank > 60 mbar for 0.5 s	Gas proportioner is defective (prerequisite) 1) ZV-AIR/O2/N2O do not close/are delayed V7-tank-flush does not open/is delayed 2) Ptank faulty? Check Ptank in service mode with closed V7. Ptank indicates ambient pressure. ΔPtank must be < 60 mbar.
0 0 2 0	1) ZV3-O2 .... open –> closed ZV1/ZV2-(AIR/N2O).... closed V7-tank-flush........... closed V10-Prop .... closed .... (0 L/min) V27-safety .... closed V28-safety MV1-V1-Pmax PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas MV6-A cone F flow control 2) Ptank is too high 3) Ptank > (P0 + 950 mbar) within 1.2 s	Gas proportioner is defective 1) ZV3 (O2) pressure is too high ZV3 (O2) does not close/is delayed ZV1/ZV2 (AIR/N2O) are open. 2) Flow through ZV3 (O2) is too high. Carry out flow calibration of pipeline inlet valves. See repair information (chapter 11.3 "CS System Inlet Valves Flow Calibration" in the Pneumatics Repair Instructions). 3) Ptank faulty? Check in service mode.

07: ZV3-O2 MA error codes (continued)		
0 0 4 0	1) ZV3-O2 closed .... --> open ZV1/ZV2-(AIR/N2O).... closed V7-tank-flush........... closed V10-prop.............. closed (0 L/min) V27-safety............. closed V28-safety MV1-V1-Pmax PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas MV6-A cone F flow control 2) Ptank is too low 3) Ptank < (P0 +750 mbar) within 1.4 s	1) no/low ZV3 (O2) pressure 2) ZV3 (O2) does not open/is delayed 3) V7-tank-flush is open. V10-prop is open (> 0 L/min) 3) Flow through ZV3 (O2) is too low. Carry out flow calibration of pipeline inlet valves. See repair information (chapter 11.3 "CS System Inlet Valves Flow Calibration" in the Pneumatics Repair Instructions). 4) Ptank faulty? Check in service mode. 5) Pipeline valves are not triggered. Ventdos Controller PCB or actuators faulty.

54.12 Test no. 08 (MA): ZV1-AIR

08: ZV1-AIR MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	

08: ZV1-AIR MA error codes (continued)		
0 0 0 2	- o.k. -	
0 0 0 4	1) ZV1-3 (AIR/N2O/O2) . . -> closed V7-tank-flush. . . . . -> open V10-prop. . . . . -> closed (0 L/min) V27-safety . . . . -> closed V28-safety MV1-V1-Pmax PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas MV6-A cone F flow control 2) Ptank is not constant 3) ΔPtank > 50 mbar; time-out after 10 s	Gas proportioner is defective (prerequisite) 1) ZV-AIR/O2/N2O do not close/are delayed V7-tank-flush does not open/is delayed 2) Ptank faulty? Check Ptank in service mode with open V7. Ptank indicates ambient pressure. ΔPtank must be < 50 mbar.
0 0 0 8	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush. . . . . open V10-prop. . . . . closed (0 L/min) V27-safety. . . . . closed V28-safety MV1-V1-P . . . . max-PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas MV6-A cone F flow control 2) Ptank is not constant 3) ΔPtank > 60 mbar for 0.5 s	Gas proportioner is defective (prerequisite) 1) ZV-AIR/O2/N2O do not close/are delayed V7-tank-flush does not open/is delayed 2) Ptank faulty? Check Ptank in service mode with open V7. Ptank indicates ambient pressure. ΔPtank must be < 60 mbar.

08: ZV1-AIR MA error codes (continued)		
0 0 0 16	1) ZV1-3 (AIR/N2O/O2) . closed V7-tank-flush open. . . . . . –> closed V10-prop . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas MV6-A cone F flow control 2) Ptank is not constant 3) ΔPtank > 60 mbar for 0.5 s	Gas proportioner is defective (prerequisite) 1) ZV-AIR/O2/N2O do not close/are delayed V7-tank-flush does not open/is delayed 2) Ptank faulty? Check Ptank in service mode with closed V7. Ptank indicates ambient pressure. ΔPtank must be < 60 mbar.
0 0 2 0	1) ZV1-AIR open . . . . –> closed ZV2/ZV3-(N2O/O2) . . . closed V7-tank-flush. . . . . closed V10-prop . . . . closed (0 L/min) V27-safety. . . . . closed V28-safety MV1-V1-Pmax PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas MV6-A cone F flow control 2) Ptank is too high 3) Ptank > (P0 + 950 mbar) within 1.2 s	Gas proportioner is defective 1) ZV1 (AIR) pressure is too high ZV1 (AIR) does not close/is delayed ZV1/ZV3 (O2/N2O) are open. 2) Flow through ZV1 (AIR) is too high. Carry out flow calibration of pipeline inlet valves. See repair information (chapter 11.3 "CS System Inlet Valves Flow Calibration" in the Pneumatics Repair Instructions). 3) Ptank faulty? Check in service mode

08: ZV1-AIR MA error codes (continued)		
0 0 4 0	1) ZV1-AIR closed . . . . -> open ZV2/ZV3-(N2O/O2) . . . . closed V7-tank-flush. . . . . closed V10-prop. . . . . closed (0 L/min) V27-safety. . . . . closed V28-safety MV1-V1-Pmax PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas MV6-A cone F flow control 2) Ptank is too low 3) Ptank < (P0 +750 mbar) within 1.4 s	1) no/low ZV1 (AIR) pressure 2) ZV1 (AIR) does not open/is delayed. 3) V7-tank-flush is open. V10-prop is open (> 0 L/min) 3) Flow through ZV1 (AIR) is too low. Carry out flow calibration of pipeline inlet valves. See repair information (chapter 11.3 "CS System Inlet Valves Flow Calibration" in the Pneumatics Repair Instructions). 4) Ptank faulty? Check in service mode. 5) Pipeline valves are not triggered. Ventdos Controller PCB or Actuator PCB faulty.

54.13 Test no. 09 (MA): ZV2-N2O

09: ZV2-N2O MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	

09: ZV2-N2O MA error codes (continued)		
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 0 0 4	1) ZV1-3 (AIR/N2O/O2) . . -> closed V7-tank-flush . . . . -> open V10-prop . . . . -> closed (0 L/min) V27 safety . . . . -> closed V28-safety MV1-V1-Pmax PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas MV6-A cone F flow control 2) Ptank is not constant 3) ΔPtank > 50 mbar; time-out after 10 s	Gas proportioner is defective (prerequisite) 1) ZV-AIR/O2/N2O do not close/are delayed V7-tank-flush does not open/is delayed 2) Ptank faulty? Check Ptank in service mode with open V7. Ptank indicates ambient pressure. ΔPtank must be < 50 mbar.
0 0 0 8	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush . . . . open V10-prop . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas MV6-A cone F flow control 2) Ptank is not constant 3) ΔPtank > 60 mbar for 0.5 s	Gas proportioner is defective (prerequisite) 1) ZV-AIR/O2/N2O do not close/are delayed V7-tank-flush does not open/is delayed 2) Ptank faulty? Check Ptank in service mode with open V7. Ptank indicates ambient pressure. ΔPtank must be < 60 mbar.

09: ZV2-N2O MA error codes (continued)		
0 0 0 16	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush open . . . . . . –> closed V10-prop . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas MV6-A cone F flow control 2) Ptank is not constant 3) ΔPtank > 60 mbar for 0.5 s	Gas proportioner is defective (prerequisite) 1) ZV-AIR/O2/N2O do not close/are delayed V7-tank-flush does not open/is delayed 2) Ptank faulty? Check Ptank in service mode with closed V7. Ptank indicates ambient pressure. ΔPtank must be < 60 mbar.
0 0 2 0	1) ZV2 (N2O) open . . . . –> closed ZV1/ZV2-(AIR/N2O). . . . closed V7-tank-flush . . . . closed V10-prop . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas F flow control 2) Ptank is too high 3) Ptank > (P0 + 950 mbar) within 1.2 s	Gas proportioner is defective 1) ZV2 (N2=) pressure is too high ZV2 (N2O) does not close/is delayed ZV1/ZV3 (AIR/N2O) are open. 2) Flow through ZV2 (N2O) is too high. Carry out flow calibration of pipeline inlet valves. See repair information (chapter 11.3 "CS System Inlet Valves Flow Calibration" in the Pneumatics Repair Instructions). 3) Ptank faulty? Check in service mode

09: ZV2-N2O MA error codes (continued)		
0 0 4 0	1) ZV2 (N2O) closed . . . . . -> open ZV1/ZV2-(AIR/N2O). . . . closed V7-tank-flush . . . . closed V10-prop . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas F flow control 2) Ptank is too low 3) Ptank < (P0 + 750 mbar) within 1.4 s	1) ZV2 (N2O) pressure is missing/too low 2) ZV2 (N2O) does not open/is delayed 3) V7-tank-flush is open. V10-prop is open (> 0 L/min) 3) Flow through ZV2 (N2O) is too low. Carry out flow calibration of pipeline inlet valves. See repair information (chapter 11.3 "CS System Inlet Valves Flow Calibration" in the Pneumatics Repair Instructions). 4) Ptank faulty? Check in service mode. 5) Pipeline valves are not triggered. Ventdos Controller PCB or actuators faulty.

54.14 Test no. 10 (MA): V7-tank-flush

10: V7-tank-flush MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	

10: V7-tank-flush MA error codes (continued)		
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 0 0 4	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush . . . . open V10-prop = ... 0 L/min 2) Prerequisite not met 3) ΔPtank > 35 mbar; time-out after 3 s	Gas proportioner is defective (prerequisite) Check Ptank in service mode. Check V7 in service mode. Fill reservoir and relieve through V7. Silicone tubing at outlet of V7 to AGS buckled?
0 0 0 8	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush . . . . open; V10-prop = ... 0 L/min 2) Ptank is not constant 3) ΔPtank > 35 mbar for 1 s	
0 0 0 16	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush . . . . closed V10-prop = ... 0 L/min 2) Ptank is not constant 3) ΔPtank > 35 mbar for 1 s	
0 0 0 32	1) ZV1/ZV3-(AIR/O2) . . . . . closed V7-tank-flush . . . . closed V10-prop = ... 0 L/min 2) Ptank is not constant 3) Ptank > (P0 + 950 mbar) within 1.2 s	
0 0 2 0	1) ZV1/ZV3-(AIR/O2) . . . . . open V7-tank-flush . . . . closed V10-prop = ... 0 L/min 2) Ptank is too low 3) Ptank < (P0 + 750 mbar) within 1.4 s	Gas proportioner is defective 1) V7-tank-flush stuck in position "open"
0 0 4 0	1) ZV1/ZV3-(AIR/O2) . . . . . closed V7-tank-flush . . . . open V10-prop = 0 L/min 2) Ptank is too high 3) Ptank > (P0 +50 mbar) within 5 s	Gas proportioner is defective 1) V7-tank-flush stuck in position "closed" 2) Silicone tubing at outlet of V7 is buckled.

54.15 Test no. 11 (MA): V10-prop

11: V10-prop MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	

54.16 Test no. 12 (MA): V27 safety valve (monostable)

12: V27 safety valve (monostable) MA error codes		
Display on the monitor (in decimal format)	1) Test environment of pneumatics 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	

12: V27 safety valve (monostable) MA error codes (continued)		
0 0 0 4	1) ZV1-3 (AIR/N2O/O2) . . -> closed V7-tank-flush . . . . -> open V10-prop . . . . -> open (12 L/min) V27 safety . . . . -> closed V28 safety . . . . -> open MV1-V1-Pmax PEEP . . . . -> open (0 mbar) MV2-V2 time control . . . . -> closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 -> AIR/O2 MV6 A-cone . . . . -> internal F flow control 2) Ptank is not constant 3) ΔPtank > 50 mbar; time-out after 10 s	Gas proportioner is defective (prerequisite) 1) ZV-AIR/O2/N2O do not close/are delayed V7-tank-flush does not open/is delayed 2) Ptank is defective 3) SV does not release (mixer) valves
0 0 0 8	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush . . . . open V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety . . . . open MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 -> AIR/O2 MV6 A-cone . . . . internal F flow control 2) Ptank is not constant 3) ΔPtank > 60 mbar for 0.5 s	Gas proportioner is defective (prerequisite)
0 0 0 16	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush open . . . . . . –> closed V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety . . . . open MV1-V1-Pmax-PEEP . . . . open (0 mbar) . . . . –> closed (70 mbar) MV2-V2 time control . . . . closed -> closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 -> AIR/O2 MV6 A-cone . . . . internal F flow control 2) Ptank is not constant 3) ΔPtank > 60 mbar for 0.5 s	Gas proportioner is defective (prerequisite) 1) Pipeline valves leakage. Pressure increase in container although valves are closed.

12: V27 safety valve (monostable) MA error codes (continued)		
0 0 2 0	1) ZV-AIR/O2/N2O ...... closed V7-tank-flush .... closed V10-prop .... open (12 L/min) V27-safety .... open -> closed V28-safety .... open MV1-V1-Pmax-PEEP .... closed (70 mbar) MV2-V2 time control .... closed MV3 control gas .... Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone .... internal F flow control 2) Ptank is too high 3) Ptank > Ptank (V27-safety closed) + 10 mbar within 5 s	Gas proportioner is defective 1) V27-safety stuck in position "open". Safety flow is too high (>8 L/min)
0 0 4 0	1) ZV-AIR/O2/N2O ...... closed V7-tank-flush .... closed V10-prop .... open (12 L/min) V27 safety .... closed -> open V28-safety .... open MV1-V1-Pmax-PEEP .... closed (70 mbar) MV2-V2 time control .... closed MV3 control gas .... Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone .... internal F flow control 2) Ptank is too low 3) Ptank < (P0 + 40 mbar) within 20 s)	Gas proportioner is defective 1) V27-safety stuck in position "closed". 2) Safety flow too low (<4 L/min) 3) Vaporizer mount or patient system is leaky

54.17 Test no. 13 (MA): V28 safety valve (bistable)

13: V28 safety valve (bistable) MA error codes		
Display on the monitor (in decimal format)	1) Test environment of pneumatics 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	

13: V28 safety valve (bistable) MA error codes (continued)		
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 0 0 4	1) ZV1-3 (AIR/N2O/O2) . . -> closed V7-tank-flush . . . . –> open V10-prop . . . . -> open (12 L/min) V27-safety . . . . –> open V28-safety . . . . –> closed MV1-V1-Pmax PEEP . . . . -> open (0 mbar) MV2-V2 time control . . . . -> closed MV3 control gas. . . . . ->Auto MV5-AIR-O2 control gas ->AIR/O2 MV6 A-cone . . . . –> internal F flow control 2) Ptank is not constant 3) ΔPtank > 50 mbar; time-out after 10 s	Gas proportioner is defective (prerequisite)
0 0 0 8	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush . . . . open V10-prop . . . . open (12 L/min) V27-safety . . . . open V28-safety . . . . closed MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas. AIR/O2 MV6 A-cone . . . . internal F flow control 2) Ptank is not constant 3) ΔPtank > 60 mbar for 0.5 s	

13: V28 safety valve (bistable) MA error codes (continued)		
0 0 0 16	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush open . . . . . . --> closed V10-prop . . . . open (12 L/min) V27-safety . . . . open V28-safety . . . . closed MV1-V1-Pmax-PEEP . . . . open (0 mbar) . . . . -> closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Ptank is not constant 3) ΔPtank > 60 mbar for 0.5 s	Gas proportioner is defective (prerequisite) 1) Pipeline valves leakage. Pressure increase in container although valves are closed.
0 0 2 0	1) ZV-AIR/O2/N2O . . . . . . closed V7-tank-flush . . . . closed V10-prop . . . . open (12 L/min) V27-safety . . . . open V28 safety . . . . open -> closed MV1-V1-Pmax-PEEP . . . . closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Ptank is too high 3) Ptank > Ptank (V28-safety closed -> open) + 10 mbar) within 5 s	Gas proportioner is defective 1) V28-safety stuck in position "open" Safety flow is too high (> 8 L/min)
0 0 4 0	1) ZV-AIR/O2/N2O . . . . . . closed V7-tank-flush . . . . closed V10-prop . . . . open (12 L/min) V27-safety . . . . open V28-safety . . . . closed -> open MV1-V1-Pmax-PEEP . . . . closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Ptank is too low 3) Ptank < (P0 + 40 mbar) within 20 s)	Gas proportioner is defective 1) V27-safety stuck in position "closed". 2) Safety flow too low (<4 L/min) 3) Vaporizer mount or patient system is leaky

54.18 Test no. 14 (MA): P flow control (Ptank/Psys)

14: P flow control (Ptank/Psys) MA error codes		
Display on the monitor (in decimals)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 0 0 4	1) ZV1-3 (AIR/N2O/O2) . -> closed V7-tank-flush . . . . -> open V10-prop . . . . -> open (12 L/min) V27-safety . . . . -> closed V28-safety MV1-V1-Pmax PEEP . . . . -> open (0 mbar) MV2-V2 time control . . . . -> closed MV3 control gas. . . . . ->Auto MV5-AIR-O2 control gas ->AIR/O2 MV6 A-cone . . . . -> internal F flow control 2) Ptank is not constant 3) ΔPtank > 50 mbar; time-out after 10 s	Gas proportioner is defective (prerequisite)
0 0 0 8	1) ZV1-3 (AIR/N2O/O2) . -> closed V7-tank-flush . . . . -> open V10-prop . . . . -> open (12 L/min) V27-safety . . . . -> closed V28-safety MV1-V1-Pmax PEEP . . . . -> open (0 mbar) MV2-V2 time control . . . . -> closed MV3 control gas. . . . . -> Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . -> internal F flow control 2) Psys is not constant 3) ΔPsys > 50 mbar; time-out after 10 s	

14: P flow control (Ptank/Psys) MA error codes (continued)		
0 0 0 16	1) ZV1/ZV2/ZV3-(AIR/N2O/O2) closed V7-tank-flush . . . . open V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Ptank is not constant 3) ΔPtank > 60 mbar for 0.5 s	Gas proportioner is defective (prerequisite)
0 0 0 32	1) ZV1/ZV2/ZV3-(AIR/N2O/O2) closed V7-tank-flush . . . . open V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas. AIR/O2 MV6 A-cone . . . . internal F flow control 2) Psys is not constant 3) ΔPsys > 60 mbar for 0.5 s	
0 0 0 64	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush open . . . . . . --> closed V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP . . . . open (0 mbar) -> . . . . closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas. AIR/O2 MV6 A-cone . . . . internal F flow control 2) Ptank is not constant 3) ΔPtank > 60 mbar for 0.5 s	1) Pipeline valves leakage. Pressure increase in container although valves are closed.

14: P flow control (Ptank/Psys) MA error codes (continued)		
0 0 0 128	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush open . . . . . . --> closed V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) . . . . --> closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Psys is not constant 3) ΔPsys > 35 mbar for 0.5 s	Gas proportioner is defective (prerequisite)
0 0 1 0	1) ZV1/ZV3 (AIR/O2) . . . . closed <--> open ZV2 (N2O) . . . . closed V7-tank-flush . . . . closed V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Psys does not reach test pressure 3) Psys < (P0 + 60 mbar) time-out after 10 s	1) Vaporizer leakage 2) Interlock 3) Leakage in patient system (hoses) User interaction: Test must be repeated
0 0 2 0	1) ZV1/ZV2/ZV3-(AIR/N2O/O2) closed V7-tank-flush . . . . closed V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Psys is not constant (at P0 + equalizing pressure (approx. 60 mbar)) 3) ΔPtank > 35 mbar for 0.5 s	Gas proportioner is defective (prerequisite)

14: P flow control (Ptank/Psys) MA error codes (continued)		
0 0 4 0	1) ZV1/ZV2/ZV3-(AIR/N2O/O2) closed V7-tank-flush . . . . open V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . closed (0 mbar) MV2-V2 time control . . . . -> closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Ptank not plausible at ambient pressure 3) Ptank – P-Norm > 500 mbar for 0.5 s	Gas proportioner is defective
0 0 8 0	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush . . . . open V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . closed (0 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas. AIR/O2 MV6 A-cone . . . . internal F flow control 2) Psys not plausible at ambient pressure 3) Psys – P-Norm > 500 mbar for 0.5 s	
0 0 16 0	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush . . . . closed V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . closed (70 mbar) MV2-V2-. . . . . time control MV3 control gas . . . . Auto MV5-AIR-O2 control gas F flow control 2) Ptank is not constant (at P0) 3) ΔPtank > 60 mbar) for 0.5 s	

14: P flow control (Ptank/Psys) MA error codes (continued)		
0 0 32 0	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush . . . . closed V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Psys constantly closed (at P0) 3) ΔPsys > 60 mbar for 0.5 s	Gas proportioner is defective
0 0 64 0	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush . . . . closed V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Ptank and Psys are too different (at P0) 3) ΔPtank - Psys > 100 mbar for 0.5 s	
0 0 128 0	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush . . . . closed V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Ptank and Psys are too different (at P0 + equalizing pressure (approx. 60 mbar)) 3) ΔPtank - Psys > 100 mbar for 0.5 s	

54.19 Test no. 15 (MA): Δ-Pmix

15: Δ-Pmix MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 0 0 4	1) ZV3-AIR/N2O/O2 ..... -> closed V7-tank-flush........... -> open V10-prop.............. -> closed (0 L/min) V27-safety .... -> closed V28-safety MV1-V1-Pmax PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas MV6-A cone F flow control 2) Ptank is not constant 3) ΔPtank > 50 mbar; time-out after 10 s	Gas proportioner is defective (prerequisite)
0 0 0 8	1) ZV1/3 (AIR/N2O/O2) .. closed V7-tank-flush........... open V10-prop.............. closed (0 L/min) V27-safety .... closed V28-safety MV1-V1-Pmax PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas MV6-A cone F flow control 2) Ptank is not constant 3) ΔPtank > 60 mbar for 0.5 s	Gas proportioner is defective (prerequisite)

15: Δ-Pmix MA error codes (continued)		
0 0 0 16	1) ZV1/3 (AIR/N2O/O2) . . closed V7-tank-flush . . . . open –> closed V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas MV6-A cone F flow control 2) Ptank is not constant during zero offset determination 3) ΔPtank > 60 mbar during zero offset determination (< 0.71 s)	Gas proportioner is defective (prerequisite) Check Ptank. 1) Pipeline valve leakage.
0 0 0 64	1) ZV1/3 (AIR/N2O/O2. . . closed V7-tank-flush. . . . . open V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas MV6-A cone F flow control 2) Measured zero offset TFFO (tank flow frequency offset) is not plausible 3) Measured zero offset TFFO (tank flow frequency offset) < 10 or > 100 ("digits")	Check TFFO in service mode. 1) Delta pmix faulty (Pressure Sensor PCB). 2) Ventdos-Controller PCB faulty.
0 0 32 0	1) ZV1/3 (AIR/N2O/O2) . . closed V7-tank-flush. . . . . open V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas MV6-A cone F flow control 2) Time-out with zero offset determination 3) T > 0.71 s with zero offset determination	

54.20 Test no. 16 (MA): Δ-Pfgf

16: Δ-Pfgf MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 0 0 4	1) ZV1/3 (AIR/O2) .... --> open ZV2 (N2O) .... --> closed V7-tank-flush .... --> closed V10-prop .... --> closed (0 L/min) V27-safety .... --> closed V28-safety MV1-V1-Pmax PEEP .... -> open (0 mbar) MV2-V2 time control .... --> closed MV3 control gas .... --> Auto MV5-AIR-O2 control gas --> AIR/O2 MV6 A-cone .... --> internal F flow control 2) Ptank is too low (neither AIR nor O2 is sufficient) 3) Ptank < (P0 + 2450 mbar; time-out after 3 s for AIR and Ptank < (P0 + 2450 mbar); time-out after 3 s for O2	Gas proportioner is defective (prerequisite) 1) AIR or O2 pipeline pressure too low. 2) Pipeline valve flow too low. Carry out flow calibration of pipeline inlet valves. See repair information (chapter 11.3 "CS System Inlet Valves Flow Calibration" in the Pneumatics Repair Instructions). 3) Leakage at V7, tank.

16: Δ-Pfgf MA error codes (continued)		
0 0 0 8	1) ZV1/3 (AIR/O2) . . . . open -> closed ZV2 (N2O) . . . . closed V7-tank-flush . . . . closed -> open V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . -> internal F flow control 2) Ptank is too high 3) Ptank > (P0 + 1200 mbar); time-out after 9 s	Gas proportioner is defective (prerequisite) Leakage at one of the pipeline valves. Ptank increasing. 1) V7 does not open. Silicone tubing at outlet of V7 to AGS buckled.
0 0 0 16	1) ZV1/3 (AIR/O2) . . . . closed -> open ZV2 (N2O) . . . . closed V7-tank-flush . . . . open -> closed V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Ptank is too low 3) Ptank < (P0 + 2450 mbar); time-out after 3 s for O2/AIR	Gas proportioner is defective (prerequisite) 1) Pipeline pressure too low. 2) Pipeline valve flow too low. Carry out flow calibration of pipeline inlet valves. See repair information (chapter 11.3 "CS System Inlet Valves Flow Calibration" in the Pneumatics Repair Instructions). 3) Leakage at V7, tank.

16: Δ-Pfgf MA error codes (continued)		
0 0 0 32	1) ZV1/3 (AIR/O2) .... open -> closed ZV2 (N2O) .... closed V7-tank-flush .... closed -> open V10-prop.............. closed (0 L/min) V27-safety .... closed V28-safety MV1-V1-Pmax-PEEP .... open (0 mbar) MV2-V2 time control .... closed MV3 control gas .... Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone .... internal F flow control 2) Ptank is too high 3) Ptank > (P0 + 1200 mbar); time-out after 9 s	Gas proportioner is defective (prerequisite) 1) Leakage at one of the pipeline valves. Ptank increasing. 2) V7 does not open. Silicone tubing at outlet of V7 to AGS buckled.
0 0 0 64	1) ZV3-AIR/O2........... closed -> open ZV2 (N2O) .... closed V7-tank-flush .... open -> closed V10-prop.............. closed (0 L/min) V27-safety .... closed V28-safety MV1-V1-Pmax-PEEP .... open (0 mbar) MV2-V2 time control .... closed MV3 control gas .... Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone .... internal F flow control 2) Ptank is too low 3) Ptank < (P0 + 2450 mbar); time-out after 3 s for O2/AIR	Gas proportioner is defective (prerequisite) 1) Pipeline pressure too low. 2) Pipeline valve flow too low. Carry out flow calibration of pipeline inlet valves. See repair information (chapter 11.3 "CS System Inlet Valves Flow Calibration" in the Pneumatics Repair Instructions). 3) Leakage at V7, tank.

16: Δ-Pfgf MA error codes (continued)		
0 0 0 128	1) ZV1/3 (AIR/O2) .... closed –> open ZV2 (N2O) .... closed V7-tank-flush........... closed V10-prop.............. closed (0 L/min) .... –> 2.5 L/min V27-safety .... closed V28-safety, MV1-V1-Pmax PEEP open (0 mbar) MV2-V2 time control .... closed MV3 control gas .... Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone .... internal F flow control 2) Ptank is too low ("post-proportioning" after compensation time) 3) Ptank < (P0 + 2450 mbar); time-out after 3 s for O2/AIR	Gas proportioner is defective (prerequisite)
0 0 1 0	1) ZV1/3 (AIR/O2) .... open –> closed ZV2 (N2O) .... closed V7-tank-flush........... closed V10-prop .... 2.5 L/min V27-safety .... closed V28-safety MV1-V1-Pmax-PEEP .... open (0 mbar) MV2-V2 time control .... closed MV3 control gas .... Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone .... internal F flow control 2) Ptank is too high ("start pressure" for calibration not reached) 3) Ptank > 2100 mbar; time-out after 9 s for O2/AIR	Gas proportioner is defective (prerequisite) 1) Stenosis at tank output port 2) V10 does not open. 3) ZV1-3 (AIR/N2O/O2) leaky 3) Ptank is defective

16: Δ-Pfgf MA error codes (continued)		
0 0 2 0	1) ZV1/3 (AIR/O2) . . . . closed ZV2 (N2O) . . . . closed V7-tank-flush . . . . closed V10-prop . . . . 2.5 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Too large (relative) set/actual deviation of the mixed gas flow 3) ΔPfgf > 50%	Gas proportioner is defective 1) Vaporizer plug-in system blocks when vaporizer is fitted. 2) Blockage in the fresh-gas line (hose from EDOS block to vaporizer plug-in system). 3) Flow through V10 too low.
0 0 4 0	1) Z3-AIR/O2 . . . . closed ZV2 (N2O) . . . . closed V7-tank-flush . . . . closed V10-prop . . . . 2.5 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Calibration factor determined is too small 3) Calibration factor for mixed-gas flow calibration value (MFA) < 0.75 Note: Calibration factor = set/actual flow = 2.5 L/min/actual flow (actual flow is determined from decrease in reservoir pressure (Ptank) versus time)	Gas proportioner is defective 1) Measured Ptank decreasing too fast: Actual flow (through sintered element) is too high. Gas flows past the sintered element: Reservoir is leaky. V7-tank-flush does not close. 2) Ptank measures incorrectly. 3) AIR was used instead of O2 (use only real gases or do not connect pipeline).

16: Δ-Pfgf MA error codes (continued)		
0 0 8 0	1) ZV1/ZV3 (AIR/O2) . . . . closed ZV2 (N2O) . . . . closed V7-tank-flush. . . . . closed V10-prop . . . . 2.5 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Calibration factor determined is too large 3) Calibration factor for mixed-gas flow calibration value (MFA) > 1.00 Note: Calibration factor = set/actual flow = 2.5 L/min/actual flow (actual flow is determined from decrease in reservoir pressure (Ptank) versus time)	Gas proportioner is defective 1) Measured Ptank decreases too slowly. Actual flow (through sintered body) is too low. Reservoir outlet is obstructed. ZV1/ZV2/ZV3-(AIR/N2O/O2) leaky. 2) Ptank faulty. 3) O2 was used instead of AIR (use only real gases or do not connect pipeline). 4) Blockage in the fresh-gas line (hose from EDOS block to vaporizer plug-in system).

16: Δ-Pfgf MA error codes (continued)		
0 0 16 0	1) ZV1/ZV3 (AIR/O2) .... closed ZV2 (N2O) .... closed V7-tank-flush........... closed V10-prop .... 2.5 L/min V27-safety .... closed V28-safety MV1-V1-Pmax-PEEP .... open (0 mbar) MV2-V2 time control .... closed MV3 control gas .... Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone .... internal F flow control 2) Ptank is too high ("end pressure" for calibration not reached) 3) Ptank > (P0 + 1490 mbar); time-out after 9 s at O2/AIR (calibration factor > 1.00) Note: Calibration factor = set/actual flow = 2.5 L/min/actual flow (actual flow is determined from decrease in reservoir pressure (Ptank) versus time)	Gas proportioner is defective 1) Measured Ptank decreases too slowly. Actual flow (through sintered body) is too low. Reservoir outlet is obstructed. ZV1/ZV2/ZV3-(AIR/N2O/O2) leaky. 2) Ptank faulty. 3) Blockage in the fresh-gas line (hose from EDOS block to vaporizer plug-in system).

54.21 Test no. 17 (MA): Mixer Leak Test

17: Mixer leak test MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	

17: Mixer leak test MA error codes (continued)		
0 0 0 2	- o.k. -	

54.22 Test no. 18 (MA): MV1/V1 Pmax-PEEP

18: MV1/V1 Pmax-PEEP MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	

18: MV1/V1 Pmax-PEEP MA error codes (continued)		
0 0 0 4	1) ZV1-3 (AIR/N2O/O2) V7-tank-flush V10-prop. . . . . -> closed (0 L/min) V27-safety . . . .-> closed V28-safety MV1-V1-Pmax PEEP. . . . .-> open (0 mbar) MV2-V2 time control . . . .-> closed MV3 control gas . . . .-> Auto MV5-AIR-O2 control gas .->AIR/O2 MV6 A-cone. . . . .-> internal F flow control. . . . . -> 30 L/min 2) Paw is not equal to ambient pressure 3) Paw > 4 mbar; time-out after 10 s	Ventilator is defective 1)Man/Spont switchover faulty. Check Man/Spont diaphragms in breathing system.
0 0 0 8	1) ZV1-3 (AIR/N2O/O2) V7-tank-flush V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . .open (0 mbar) MV2-V2 time control . . . .closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control . . . . .30 L/min 2) Paw is not equal to ambient pressure 3) Paw > 5 mbar for 0.5 s	
0 0 32 0	1) ZV1-3 (AIR/N2O/O2) V7-tank-flush V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . .open (0 mbar) MV2-V2 time control . . . .open MV3 control gas . . . . Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control . . . . .30 L/min 2) Paw and (adjusted) PEEP (0 mbar) are too different 3) Paw > 2 mbar for 2 s (adjusted PEEP = 0 mbar)	1)Man/Spont switchover faulty. Check Man/Spont diaphragms in breathing system. 2) Check Pvor 1.8 bar. 3) Check 2 L/min flow through PEEP valve. 4) PEEP valve offset is too high. Check in service mode

18: MV1/V1 Pmax-PEEP MA error codes (continued)		
0 0 64 0	1) ZV1-3 (AIR/N2O/O2) V7-tank-flush V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP . . . .20 mbar MV2-V2 time control . . . .open MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control . . . . .30 L/min 2) Paw and (adjusted) PEEP (20 mbar) are too different 3) Paw - 21 mbar > 4 mbar within 2 s (adjusted PEEP = 20 mbar)	1)Man/Spont switchover faulty. Check Man/Spont diaphragms in breathing system. 2) Check Pvor 1.8 bar. 3) Check 2 L/min flow through PEEP valve. 4) Check PEEP valve at 20 mbar in service mode.

54.23 Test no. 19 (MA): MV2/V2 time control

19: MV2/V2 time control MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	

19: MV2/V2 time control MA error codes (continued)		
0 0 0 4	1) ZV1-3 (AIR/N2O/O2) . . .closed V7-tank-flush V10-prop . . . . .0 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP . . . .0 mbar MV2-V2 time control . . . .closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . -> internal F flow control . . . . max. (75 L/min) 2) Paw is not constant 3) Paw > 5 mbar; time-out after 3 s	Ventilator is defective (prerequisite)
0 0 0 8	1) ZV1-3 (AIR/N2O/O2) . . .closed V7-tank-flush V10-prop . . . . .0 L/min V27-safety. . . . . closed V28-safety MV1-V1-Pmax PEEP . . . .0 mbar MV2-V2 time control . . . .closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . internal F flow control . . . . max. (75 L/min) 2) Paw is not constant 3) Paw > 5 mbar for 0.5 s	

19: MV2/V2 time control MA error codes (continued)		
0 0 0 16	1) ZV1-3 (AIR/N2O/O2) . . .) closed V7-tank-flush V10-prop . . . . .0 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP . . . . 0 mbar --> 70 mbar MV2-V2 time control . . . .closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control . . . . max. (75 L/min) 2) Paw is not constant 3) Paw > 5 mbar for 0.5 s	Ventilator is defective (prerequisite)
0 0 8 0	1) ZV1/ZV2/ZV3-(AIR/N2O/O2) closed V7-tank-flush V10-prop . . . . .0 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP . . . .70 mbar MV2-V2 time control . . . . closed –> open MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control . . . . max. (75 L/min) 2) Paw exceeds test pressure 3) Paw > (P0 + 75 mbar) for 1 s	
0 0 10 0	1) ZV1-3 (AIR/N2O/O2) . . .closed V7-tank-flush V10-prop . . . . .0 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP . . . .70 mbar MV2-V2 time control . . . .open –> closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control . . . . max. (75 L/min) 2) Paw does not reach test pressure 3) Paw < (P0 + 30 mbar); time-out after 2 s	

54.24 Test no. 20 (MA): MV3 control gas switch

20: MV3 control gas switch MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	

54.25 Test no. 21 (MA): V4-Auto-Man/Spont

21: V4-Auto-Man/Spont MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	

21: V4-Auto-Man/Spont
MA error codes (continued)

0 0 0 4	1) ZV1/ZV2/ZV3-(AIR/N2O/O2) V7-tank-flush V10-prop . . . . 0 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP . . . . 0 mbar MV2-V2 time control . . . . closed MV3 control gas . . . . Man/Spont MV5-AIR-O2 control gas AIR/O2 MV6 A-cone. . . . . -> internal F flow control . . . . 40 L/min 2) Paw is not constant 3) ΔPaw > 5 mbar; time-out after 3 s	Ventilator is defective (prerequisite)
0 0 0 8	1) ZV1/ZV2/ZV3-(AIR/N2O/O2) V7-tank-flush V10-prop . . . . 0 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP . . . . 0 mbar MV2-V2 time control . . . . closed MV3 control gas . . . . Man/Spont MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control . . . . 40 L/min 2) Paw is not constant 3) ΔPaw > 5 mbar for 0.5 s	
0 0 0 16	1) ZV1-3 (AIR/N2O/O2) V7-tank-flush V10-prop . . . . 0 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP . . . . 0 mbar MV2-V2 time control . . . . closed MV3 control gas Man/Spont –> Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control . . . . 40 L/min 2) Paw does not reach a constant (P0) pressure 3) Paw > 5 mbar; time-out after 3 s	

21: V4-Auto-Man/Spont MA error codes (continued)		
0 0 0 32	1) ZV1-3 (AIR/N2O/O2) . . . closed V7-tank-flush V10-prop . . . . 0 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP . . . . 0 mbar MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control . . . . 40 L/min 2) Paw is not constant at (P0) pressure 3) Paw > 5 mbar for 0.5 s	Ventilator is defective (prerequisite)
0 0 0 64	1) ZV1/ZV2/ZV3-(AIR/N2O/O2) V7-tank-flush V10-prop . . . . 0 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP ManSpont pressure . . . . . + 30 mbar (if ManSpont pressure was < 30 mbar) or Man/Spont pressure . . . . - 30 mbar (if Man/Spont pressure was > 30 mbar) or MV2-V2 time control open –> closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control . . . . 40 L/min 2) Paw is not constant at test pressure 3) Paw - test pressure > 10 mbar for 1 s (test pressure = Man/Spont pressure + 30 mbar (if Man/Spont pressure was < 30 mbar) or Man/Spont pressure - 30 mbar (if ManSpont pressure was > 30 mbar)	

21: V4-Auto-Man/Spont MA error codes (continued)		
0 32 0 0	1) ZV1/ZV2/ZV3-(AIR/N2O/O2) V7-tank-flush V10-prop . . . . 0 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP . . . . 0 mbar MV2-V2 time control . . . . closed MV3 control gas Auto . . . --> Man/Spont MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control . . . . 40 L/min 2) Paw does not reach initial Man/Spont pressure 3) Paw > test pressure - 5 mbar after 1 s or Paw < test pressure + 5 mbar after 1 s test pressure Man/Spont pressure + 30 mbar (if Man/Spont pressure was < 30 mbar) or Man/Spont pressure - 30 mbar (if Man/Spont pressure was > 30 mbar) or	Ventilator is defective
0 64 0 0	1) ZV1-3 (AIR/N2O/O2) V7-tank-flush V10-prop . . . . 0 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP ManSpont pressure . . . . . + 30 mbar (if Man/Spont pressure was < 30 mbar) or or Man/Spont pressure - 30 mbar (if Man/Spont pressure was > 30 mbar) or . . . . -> 70 mbar MV2-V2 time control closed --> open MV3 control gas . . . . Man/Spont MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control . . . . 40 L/min 2) Paw exceeds last Man/Spont pressure 3) Paw > test pressure + 5 mbar for 1 s (test pressure = last measured pressure in Man/Spont)	Ventilator is defective

21: V4-Auto-Man/Spont MA error codes (continued)		
0 128 0 0	1) ZV1-3 (AIR/N2O/O2) V7-tank-flush V10-prop . . . . 0 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP . . . . 0 mbar -> ManSpont pressure . . . . . + 30 mbar (if Man/Spont pressure was < 30 mbar) or or Man/Spont pressure - 30 mbar (if Man/Spont pressure was > 30 mbar) MV2-V2 time control closed ->open MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control . . . . 40 L/min 2) Paw does not reach test pressure 3) Paw - test pressure > 10 mbar; time-out after 3 s test pressure Man/Spont pressure + 30 mbar (if Man/Spont pressure was < 30 mbar) Man/Spont pressure - 30 mbar (if Man/Spont pressure was > 30 mbar)	Ventilator is defective

54.26 Test no. 22 (MA): MV6 A-cone

22: MV6 A-cone MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	

22: MV6 A-cone MA error codes (continued)		
0 0 0 4	1) ZV1/ZV3-(AIR/O2) . . . . . open <-> closed ZV2 (N2O) . . . . -> closed V7-tank-flush . . . . -> closed V10-prop . . . . -> closed 0 L/min V27-safety . . . . -> closed V28-safety MV1-V1-Pmax PEEP . . . . -> open 0 mbar MV2-V2 time control . . . . -> closed MV3 control gas. . . . . -> Auto MV5-AIR-O2 control gas. -> AIR/O2 MV6 A-cone . . . . -> internal F flow control 2) Paw is higher than ambient pressure 3) Paw > 4 mbar; time-out after 10 s	

22: MV6 A-cone MA error codes (continued)		
0 0 0 8	1) ZV1/ZV3-(AIR/O2) . . . . . open <–> closed ZV2 -(N2O) . . . . closed V7-tank-flush . . . . closed V10-prop . . . . –> closed 0 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP . . . . –> open 0 mbar MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . -> internal F flow control 2) Paw is higher than ambient pressure 3) Paw > 4 mbar; time-out after 10 s Note: Test environment prior to this test step (duration: 3 s): ZV1/ZV3-(AIR/O2) . . . . . open <–> closed ZV2 -(N2O) . . . . closed V7-tank-flush . . . . closed V10-prop . . . . –> open 1 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP . . . . –> closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . -> external F flow control (only the SV checks the A-cone "external" position using a proximity switch)	

22: MV6 A-cone MA error codes (continued)		
0 0 32 0	1) ZV1/ZV3-(AIR/O2) . . . . . open <--> closed ZV1/ZV2/ZV3-(AIR/N2O/O2) closed V7-tank-flush . . . . closed V10-prop . . . . -> open 12 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP . . . . -> closed 70 mbar MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Paw is too low 3) Paw <= 20 mbar; time-out after 10 s	

54.27 Test no. 22 (SV): MV6 A-cone

22: MV6 A-cone SV error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	

22: MV6 A-cone SV error codes (continued)		
0 0 0 4	1) Configuration of pneumatics by the MA (especially A-cone –> "external") 2) A-cone did not switch to "external" 3) -	Proximity switch defective
0 0 0 8	1) Configuration of pneumatics by the MA 2) A-cone did not switch to "internal" (especially A-cone –> "external") 3) -	

54.28 Test no. 23 (MA): Psi safety valve

23: Psi safety valve MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	1) Safety valve defective/set incorrectly
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 0 0 4	1) ZV1/ZV2/ZV3-(AIR/N2O/O2) V7-tank-flush V10-prop. . . . . -> closed (0 L/min) V27-safety . . . .-> closed V28-safety MV1-V1-Pmax PEEP . . . . .-> open (0 mbar) MV2-V2 time control . . . .-> closed MV3 control gas . . . .->Auto MV5-AIR-O2 control gas .->AIR/O2 MV6 A-cone . . . . -> internal F flow control. . . . . -> 40 L/min 2) Paw is not equal to ambient pressure 3) Paw > 4 mbar; time-out after 10 s	Ventilator is defective (prerequisite) 1) Safety valve defective/set incorrectly

23: Psi safety valve **MA error codes (continued)**		
0 0 0 8	1) ZV1/ZV2/ZV3-(AIR/N2O/O2) V7-tank-flush V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . .open (0 mbar) MV2-V2 time control . . . .closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas .AIR/O2 MV6 A-cone . . . . internal F flow control . . . . .40 L/min 2) Paw is not equal to ambient pressure 3) Paw > 5 mbar for 0.5 s	Ventilator is defective (prerequisite) 1) Safety valve defective/set incorrectly
0 0 0 16	1) ZV1/ZV2/ZV3-(AIR/N2O/O2) V7-tank-flush V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . .open (0 mbar) . . . .--> closed (100 mbar) MV2-V2 time control . . . .closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control . . . . .40 L/min 2) Paw is not equal to ambient pressure 3) Paw > 5 mbar for 0.5 s	Ventilator is defective (prerequisite) 1) Safety valve defective/set incorrectly

23: Psi safety valve MA error codes (continued)		
0 1 0 0	1) ZV1/ZV2/ZV3-(AIR/N2O/O2) V7-tank-flush V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . .closed (100 mbar) MV2-V2 time control . . . .open MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control . . . . .40 L/min 2) Paw is too low 3) Paw < 65 mbar for 3 s	User action 1) Safety valve defective/set incorrectly 2) PEEP valve outside tolerance. 3) Carry out TS23 in service mode. To do so, seal hose to safety valve. If the PSI pressure is > 90 mbar, the safety valve is defective.
0 2 0 0	1) ZV1/ZV2/ZV3-(AIR/N2O/O2) V7-tank-flush V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . .closed (100 mbar) MV2-V2 time control . . . .open MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control . . . . .40 L/min 2) Paw is too high 3) Paw > 95 mbar for 3 s	1) Safety valve is stuck.

54.29 Test no. 24 (MA): APL valve

24: APL valve MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)

24: APL valve MA error codes (continued)		
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 0 0 4	1) ZV1-3 (AIR/N2O/O2) . .-> closed V7-tank-flush . . . .-> open V10-prop . . . .-> open (12 L/min) V27-safety . . . .-> closed V28-safety MV1-V1-Pmax PEEP . . . . .-> open (0 mbar) MV2-V2 time control . . . .-> closed MV3 control gas . . . .-> Auto MV5-AIR-O2 control gas .->AIR/O2 MV6 A-cone . . . .-> internal F flow control 2) Paw is not equal to ambient pressure 3) Paw > 4 mbar; time-out after 10 s	Ventilator is defective (prerequisite) 1) Paw sensors are defective 2) Breathing system is defective
0 0 0 8	1) ZV1-3 (AIR/N2O/O2) . . .closed V7-tank-flush . . . . open V10-prop . . . . .open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . .open (0 mbar) MV2-V2 time control . . . .closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control 2) Paw is not equal to ambient pressure 3) Paw > 5 mbar for 0.5 s	Ventilator is defective (prerequisite)

24: APL valve MA error codes (continued)		
0 0 0 16	1) ZV1/ZV2/ZV3-(AIR/N2O/O2) closed V7-tank-flush .... open –> closed V10-prop ....open (12 L/min) V27-safety .... closed V28-safety MV1-V1-Pmax-PEEP ....open (0 mbar) ....–> closed (70 mbar) MV2-V2 time control ....closed MV3 control gas ....Auto –> minus point MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone ....internal F flow control 2) Paw is not equal to ambient pressure 3) Paw > 5 mbar for 0.5 s	Ventilator is defective (prerequisite) **Not** generated for the time being.

24: APL valve MA error codes (continued)		
0 1 0 0	1) ZV1/ZV3 (AIR/O2) . . . . . open -> closed . . . . (previously: 20 s open <-> closed) ZV2 (N2O) . . . . .closed V7-tank-flush . . . . .closed V10-prop . . . . .open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . .closed (70 mbar) MV2-V2 time control . . . .open MV3 control gas . . . . .Man/Spont MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control 2) Paw is too low 3) Paw < 20 mbar for 1 s	User action 1) APL valve is defective. Test according to Test Certificate.
0 2 0 0	1) ZV1/ZV3 (AIR/O2) . . . . . open -> closed . . . . (previously: 20 s open <-> closed) ZV2 (N2O) . . . . .closed V7-tank-flush . . . . .closed V10-prop . . . . .12 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . .closed (70 mbar) MV2-V2 time control . . . .open MV3 control gas . . . . .Man/Spont MV5-AIR-O2 control gas .AIR/O2 MV6 A-cone . . . . internal F flow control 2) Paw is too high 3) Paw > 40 mbar for 1 s	

54.30 Test no. 25 (MA): RV non-return valve

25: RV non-return valve MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)

25: RV non-return valve
MA error codes (continued)

0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	

54.31 Test no. 26 (MA): MV5 AIR/O2 control gas

26: MV5 AIR/O2 control gas
MA error codes

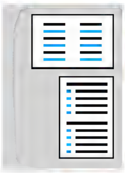
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	

54.32 Test no. 27 (MA): F flow control

27: F flow control
MA error codes

Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)

27: F flow control MA error codes (continued)		
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 4 0 0	1) ZV1/ZV2/ZV3-(AIR/N2O/O2) V7-tank-flush V10-Prop V27-safety V28-safety MV1-V1-Pmax PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas MV6 A-cone . . . . -> internal F flow control . . . . -> 0 L/min 2) F flow control does not reach start position 3) 0 L/min not reached within 20 s	Ventilator is defective
0 8 0 0	1) ZV1/ZV2/ZV3-(AIR/N2O/O2) V7-tank-flush V10-Prop V27-safety V28-safety MV1-V1-Pmax PEEP MV2-V2 time control MV3 control gas MV5-AIR-O2 control gas MV6 A-cone . . . . internal F flow control . . . . 0 L/min –> 20 L/min 2) F flow control does not reach reference position 3) (Measured) light barrier operations < 3; time-out after 30 s	Ventilator is defective 1) Slot valve is defective 2) Actuator P CB is faulty



54.33 Test no. 28 (MA): P-Ventilation (Paw/Pvor/Ptank)

28: P-Ventilation (Paw/Pvor/Ptank), MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	

28: P-Ventilation (Paw/Pvor/Ptank), MA error codes (continued)		
0 0 0 4	1) ZV1-3 (AIR/N2O/O2) . . .-> closed V7-tank-flush . . . .-> open V10-prop . . . .-> open (12 L/min) V27-safety . . . .-> closed V28-safety MV1-V1-Pmax PEEP. . . . .-> open (0 mbar) MV2-V2 time control . . . .-> closed MV3 control gas . . . .->Auto MV5-AIR-O2 control gas ->AIR/O2 MV6 A-cone. . . . .-> internal F flow control 2) Ptank is not constant 3) ΔPtank . . . . > 50 mbar; time-out after 10 s	Ventilator is defective (prerequisite)
0 0 0 8	1) ZV1-3 (AIR/N2O/O2) . . .-> closed V7-tank-flush . . . . -> open V10-prop . . . .-> open (12 L/min) V27 safety . . . .-> closed V28-safety MV1-V1-Pmax PEEP. . . . .-> open (0 mbar) MV2-V2 time control . . . .-> closed MV3 control gas . . . .-> Auto MV5-AIR-O2 control gas ->AIR/O2 MV6 A-cone . . . . .internal F flow control 2) Paw is not constant 3) ΔPaw . . . . > 4 mbar; time-out after 10 s	
0 0 0 16	1) ZV1-3 (AIR/N2O/O2) . . . -> closed V7-tank-flush . . . .-> open V10-prop . . . .-> open (12 L/min) V27-safety . . . .-> closed V28-safety MV1-V1-Pmax PEEP. . . . .-> open (0 mbar) MV2-V2 time control . . . .-> closed MV3 control gas . . . .-> Auto MV5-AIR-O2 control gas ->AIR/O2 MV6 A-cone . . . . .internal F flow control 2) Pvor is not constant 3) ΔPvor . . . .> 100 mbar; time-out after 10 s	1) Check Pvor in service mode.

28: P-Ventilation (Paw/Pvor/Ptank), MA error codes (continued)		
0 0 0 32	1) ZV1-3 (AIR/N2O/O2) . . . closed V7-tank-flush . . . . open V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Ptank is not constant 3) ΔPtank . . . . > 60 mbar for 5 s	1) Check Ptank in service mode.
0 0 0 64	1) ZV1-3 (AIR/N2O/O2) . . . closed V7-tank-flush . . . . open V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Paw is not constant 3) ΔPaw . . . . > 5 mbar for 5 s	1) Check Paw in service mode.
0 0 0 128	1) ZV1-3 (AIR/N2O/O2) . . . closed V7-tank-flush . . . . open V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Pvor is not constant 3) ΔPvor. . . . . > 150 mbar within 5 s	1) Check Pvor in service mode.

28: P-Ventilation (Paw/Pvor/Ptank), MA error codes (continued)		
0 0 1 0	1) ZV1-3 (AIR/N2O/O2) . . . closed V7-tank-flush . . . . open –> closed V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) . . . . –> closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Ptank is not equal to ambient pressure 3) Ptank - Ptank (P0) . . . . . . > 60 mbar for 0.5 s	1) Check Ptank in service mode.
0 0 2 0	1) ZV1-3 (AIR/N2O/O2) . . . closed V7-tank-flush . . . . open –> closed V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) . . . . –> closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Paw is not equal to ambient pressure 3) Paw - Paw (P0) . . . . > 5 mbar for 0.5 s	1) Check Paw in service mode.
0 0 4 0	1) ZV1-3 (AIR/N2O/O2) . . . closed V7-tank-flush . . . . open –> closed V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP. . . . . open (0 mbar) –> closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Pvor is not equal to ambient pressure 3) Pvor - Pvor (P0) . . . . > 150 mbar for 0.5 s	1) Compare Pvor with Ptank at ambient pressure.

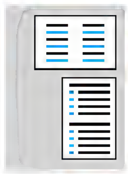
28: P-Ventilation (Paw/Pvor/Ptank), MA error codes (continued)

0 0 8 0	1) ZV1/ZV3 (AIR/O2) . . . . . closed <-> open ZV2 (N2O). . . . . .closed V7-tank-flush . . . . .closed V10-prop . . . . .open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP. . . . .closed (70 mbar) MV2-V2 time control . . . .closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . .internal F flow control 2) Paw does not reach test pressure 3) Paw . . . .< (P0 + 60 mbar) time-out after 10 s	1) Leakage in patient system, interface to patient system. 2) Check Pvor, check PEEP valve.
0 0 16 0	1) ZV1/ZV3 (AIR/O2) . . . . . closed ZV2 (N2O). . . . . .closed V7-tank-flush . . . . .closed V10-prop . . . . .open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP. . . . .closed (70 mbar) MV2-V2 time control . . . .closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . .internal F flow control 2) Paw is not constant at test pressure (P0 +"equalizing pressure" (approx. 60 mbar) after 1 s) 3) Paw – Paw (60 mbar) . . .> 10 mbar for 0.5 s	1) Leakage in patient system, interface to patient system. 2) Check the PEEP valve.
0 0 32 0	1) ZV1-3 (AIR/N2O/O2) . . .closed V7-tank-flush . . . . open V10-prop . . . . .open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP. . . . . open (0 mbar) MV2-V2 time control . . . .closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . .internal F flow control 2) Ptank not plausible at ambient pressure 3) Ptank - P-norm . . . .> 500 mbar within 10 s	1) Check Ptank in service mode.

28: P-Ventilation (Paw/Pvor/Ptank), MA error codes (continued)		
0 0 64 0	1) ZV1-3 (AIR/N2O/O2) . . . closed V7-tank-flush . . . . open V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Paw is not plausible at ambient pressure 3) Paw - P-zero . . . . > 10 mbar within 10 s	1) Check PawV in service mode. 2) Check Pvor and PEEP valve. 3) Check Man/Spont switchover diaphragm in patient system.
0 0 128 0	1) ZV1-3 (AIR/N2O/O2) . . . closed V7-tank-flush . . . . open V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Pvor is not plausible at ambient pressure 3) Pvor - P-norm. . . . . > 500 mbar for 10 s	1) Check Pvor sensor in service mode.
0 1 0 0	1) ZV1-3 (AIR/N2O/O2) . . . closed V7-tank-flush . . . . open V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Paw calibration error (not at ambient pressure) 3) Offset of Paw + 26 mbar. > 5 mbar	1) Check PawV in service mode. 2) Check PEEP valve offset. Check 2 L/min flow of PEEP valve. Check Pvor.

28: P-Ventilation (Paw/Pvor/Ptank), MA error codes (continued)		
0 2 0 0	1) ZV1-3 (AIR/N2O/O2) . . . closed V7-tank-flush . . . . closed V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP. . . . . closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Ptank is not equal to ambient pressure 3) Ptank - Ptank (P0) . . . . . . > 60 mbar for 0.5 s	1) Check Ptank in service mode. Valve positions according to test environment. No increase in pressure may occur.
0 4 0 0	1) ZV1-3 (AIR/N2O/O2) . . . closed V7-tank-flush . . . . closed V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP. . . . . closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 F flow control 2) Paw is not equal to ambient pressure 3) Paw - Paw (P0) . . . . > 5 mbar for 0.5 s	1) Check PawV in service mode. Valve positions according to test environment. No increase in pressure may occur.
0 8 0 0	1) ZV1-3 (AIR/N2O/O2) . . . closed V7-tank-flush . . . . closed V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP. . . . . closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Pvor is not equal to ambient pressure 3) Pvor - Pvor (P0). . . . . > 150 mbar for 0.5 s	1) Check Pvor in service mode.

28: P-Ventilation (Paw/Pvor/Ptank), MA error codes (continued)		
0 16 0 0	1) ZV1/3 (AIR/O2) .... closed ZV2 (N2O)............. closed V7-tank-flush .... closed V10-prop .... open (12 L/min) V27-safety .... closed V28-safety MV1-V1-Pmax-PEEP..... closed (70 mbar) MV2-V2 time control .... closed MV3 control gas .... Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone .... internal F flow control 2) Ptank and Pvor are too different at P0 3) Ptank and Pvor .... > 100 mbar for 0.5 s	1) Check Ptank and Pvor in service mode according to Test Certificate. Max. deviation 100 mbar.
0 32 0 0	1) ZV1/ZV3-(AIR/O2) ..... closed ZV2 (N2O)............. closed V7-tank-flush .... closed V10-prop .... open (12 L/min) V27-safety .... closed V28-safety MV1-V1-Pmax-PEEP..... closed (70 mbar) MV2-V2 time control .... closed MV3 control gas .... Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone .... internal F flow control 2) Ptank and Pvor are too different at test pressure (P0 +"equalizing pressure" (approx. 60 mbar) after 1 s) 3) Ptank (60 mbar) - and Pvor (60 mbar) > 100 mbar for 0.5 s	1) Check Ptank and Pvor in service mode according to Test Certificate. Max. deviation 100 mbar.



54.34 Test no. 28 (SV): P-Ventilation (Paw/Pvor/Ptank)

28: P-Ventilation (Paw/Pvor/Ptank), SV error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	Not generated for the time being.
0 0 0 2	- o.k. -	

28: P-Ventilation (Paw/Pvor/Ptank), SV error codes (continued)		
0 0 0 4	1) Configuration of pneumatics by the MA 2) Ptank is not constant 3) ΔPtank 100 mbar; time-out after 10 s	Ventilator is defective (prerequisite)
0 0 0 8	1) Configuration of pneumatics by the MA 2) Paw is not constant 3) ΔPaw > 4 mbar; time-out after 10 s	
0 0 0 16	1) Configuration of pneumatics by the MA 2) Pvor is not constant 3) ΔPvor > 100 mbar; time-out after 10 s	
0 0 0 32	1) Configuration of pneumatics by the MA 2) Ptank is not constant 3) ΔPtank > 150 mbar for 5 s	
0 0 0 64	1) Configuration of pneumatics by the MA 2) Paw is not constant 3) ΔPaw > 5 mbar for 5 s	
0 0 0 128	1) Configuration of pneumatics by the MA 2) Pvor is not constant 3) ΔPvor > 150 mbar within 5 s	
0 0 1 0	1) Configuration of pneumatics by the MA 2) Paw is not equal to ambient pressure 3) Paw - Paw (P0) > 150 mbar for 0.5 s	
0 0 2 0	1) Configuration of pneumatics by the MA 2) Paw is not equal to ambient pressure 3) Paw - Paw (P0) > 5 mbar for 0.5 s	
0 0 4 0	1) Configuration of pneumatics by the MA 2) Pvor is not equal to ambient pressure 3) Pvor - Pvor (P0) > 150 mbar for 0.5 s	Ventilator is defective (prerequisite)

28: P-Ventilation (Paw/Pvor/Ptank), SV error codes (continued)

0 0 8 0	1) Configuration of pneumatics by the MA 2) Paw does not reach test pressure 3) Paw < (P0 + 30 mbar); time-out after 10 s	Ventilator is defective (prerequisite) Not generated for the time being.
0 0 16 0	1) Configuration of pneumatics by the MA 2) Ptank does not "detect" maximum test pressure 3) ΔPtank >...mbar; time-out after 10 s	
0 0 32 0	1) Configuration of pneumatics by the MA 2) Paw does not "detect" maximum test pressure 3) ΔPaw >...mbar; time-out after 10 s	
0 0 64 0	1) Configuration of pneumatics by the MA 2) Pvor does not "detect" maximum test pressure 3) ΔPvor >...mbar; time-out after 10 s	
0 0 128 0	1) Configuration of pneumatics by the MA 2) Paw calibration error 3) Offset of Paw + 26 mbar > 5 mbar	Ventilator is defective
0 1 0 0	1) Configuration of pneumatics by the MA 2) Ptank and Paw are too different at P0 3) Ptank - Paw > (Ptank (P0) - Paw (P0)) + 150 mbar within 1 s	
0 2 0 0	1) Configuration of pneumatics by the MA 2) Ptank and Pvor are too different at P0 3) Ptank - Pvor > (Ptank (P0) - Pvor (P0)) + 200 mbar within 1 s	
0 4 0 0	1) Configuration of pneumatics by the MA 2) Paw and Pvor are too different at P0 3) Paw - Pvor > (Paw (P0) - Pvor (P0)) + 150 mbar within 1 s	

28: P-Ventilation (Paw/Pvor/Ptank), SV error codes (continued)		
0 8 0 0	1) Configuration of pneumatics by the MA 2) Paw lower than test pressure before determination of maximum pressure ("plausibility") 3) Paw < (P0 + 30 mbar) for 0.5 s	Ventilator is defective Not generated for the time being.
0 16 0 0	1) Configuration of pneumatics by the MA 2) Paw is not constant at maximum (P0 + "detected" maximum test pressure) 3) Paw - Paw (Pmax) > 10 mbar for 0.5 s (Pmax > 30 mbar)	
0 32 0 0	1) Configuration of pneumatics by the MA 2) Ptank and Paw are too different at maximum test pressure (P0 + "detected" maximum test pressure) 3) Ptank (Pmax) - Paw (Pmax) > (Ptank (P0) - Paw (P0)) + 150 mbar for 0.5 s	
0 64 0 0	1) Configuration of pneumatics by the MA 2) Ptank and Pvor are too different at maximum test pressure (P0 + "detected" maximum test pressure) 3) Ptank (Pmax) - Pvor (Pmax) > (Ptank (P0)) - Pvor (P0) + 200 mbar for 0.5 s	
0 128 0 0	1) Configuration of pneumatics by the MA 2) Paw and Pvor are too different at maximum test pressure (P0 + "detect" maximum test pressure) 3) Paw (Pmax) - Pvor (Pmax) > (Ptank (P0) - Pvor (P0)) + 150 mbar for 0.5 s	

54.35 Test no. 29 (MA): Leak test during "Auto" ventilation mode

The following MA error codes in test no. 29 **depend on the software version!**

The MA error codes in test no. 29 **are valid for software versions 1.n.**

As from software versions 2.n, test no. 29 is part of test no. 32 (see test no. 32 MA!).

29: Leak test during "Auto" **MA error codes**		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 0 0 4	1) ZV1-3 (AIR/N2O/O2) . .-> closed V7-tank-flush . . . .-> open V10-prop . . . .-> open (12 L/min) V27-safety . . . .-> closed V28-safety MV1-V1-Pmax PEEP . . . . .-> open (0 mbar) MV2-V2 time control . . . .-> closed MV3 control gas . . . .-> Auto MV5-AIR-O2 control gas .->AIR/O2 MV6 A-cone . . . .-> internal F flow control 2) Paw is not equal to ambient pressure 3) Paw > 4 mbar; . . . . .time-out after 10 s	Ventilator is defective

29: Leak test during "Auto" MA error codes (continued)		
0 0 0 8	1) ZV1-3 (AIR/N2O/O2) . . .closed V7-tank-flush . . . . open V10-prop . . . . .open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . .open (0 mbar) MV2-V2 time control . . . .closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control 2) Paw is not equal to ambient pressure 3) Paw > 5 mbar for 0.5 s	Ventilator is defective
0 0 0 16	1) ZV1-3 (AIR/N2O/O2) . . .closed V7-tank-flush . . . . open -> closed V10-prop . . . . .open (12 L/min) --> 6 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax PEEP . . . . . open (0 mbar) -> closed (70 mbar) MV2-V2 time control . . . .closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control 2) Paw is not equal to ambient pressure 3) Paw > 5 mbar for 0.5 s	
0 0 0 32	1) ZV1/3 (AIR/O2) . . . . closed <-> open ZV2 (N2O) . . . . .closed V7-tank-flush . . . . .closed V10-prop . . . . .5 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . .closed (70 mbar) MV2-V2 time control . . . .closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control 2) Paw does not reach test pressure 3) Paw < 30 mbar; . . . . .time-out after 5 s	Ventilator is defective

29: Leak test during "Auto" MA error codes (continued)		
0 2 0 0	1) ZV1/3 (AIR/O2) . . . .(closed <–> open) -> closed ZV2 (N2O) . . . . .closed V7-tank-flush . . . . .closed V10 prop . . . . closed (0 L/min) –> 5 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . .closed (70 mbar) MV2-V2 time control . . . .closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control 2) Leak greater than upper limit 3) Leak > 150 mL/min	User action

29: Leak test during "Auto" MA error codes (continued)		
0 16 0 0	1) ZV1/3 (AIR/O2) . . . .(closed <--> open) -> closed ZV2 (N2O) . . . . .closed V7-tank-flush . . . . .closed V10 prop . . . . .5 L/min --> closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . .closed (70 mbar) MV2-V2 time control . . . .closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control 2) After expiration of leak test time, Paw is greater than (initial) test pressure 3) Paw > 30 mbar + 5 mbar after 15 s	User action
1 0 0 0	1) ZV1/3 (AIR/O2) . . . . closed <--> open ZV2 (N2O) . . . . .closed V7-tank-flush . . . . .closed V10 prop . . . . closed (0 L/min) --> 5 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . .closed (70 mbar) MV2-V2 time control . . . .closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control 2) Paw does not reach (initial) test pressure any more (leak too great?) 3) Paw < 30 mbar + 5 mbar after 5 s	

54.36 Test no. 30 (MA): Leak test during "Man/Spont" ventilation mode

30: Leak test during "Man/Spont" MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	

54.37 Test no. 31 (MA): Bellows leak test

31: Bellows leak test MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	

31: Bellows leak test MA error codes (continued)		
0 0 0 2	1) V3-(O2/Air/N2O) . . . . . . closed V7-tank-flush . . . . closed PV1-Prop . . . . closed (0 L/min) V27-safety . . . . closed V28-safety . . . . - MV1-V1-Pmax-PEEP . . . . closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas Air/O2 MV6 A-cone . . . . internal F flow control . . . . 30 L/min Bellows . . . . not down Emitter Bellows light barrier . . . . off <–> on 2) Light-barrier error 3) Emitter is on, detector is off	1) Bellows is (still) in the light-barrier range. 2) Light-barrier emitter is defective - light-barrier detector is defective. 3) Light barrier response times for emitter and/or detector are greater than 20 ms. 4) RV1 leak in breathing system 5) SW 2.02 : Hardware for bellows detection not present, but configured in service mode "service 2".
0 0 0 4	1) V3-(O2/Air/N2O) . . . . . . closed V7-tank-flush . . . . closed PV1-Prop . . . . closed (0 L/min) V27-safety . . . . closed V28-safety - MV1-V1-Pmax-PEEP . . . . closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas Air/O2 MV6 A-cone . . . . internal F flow control . . . . 30 L/min Bellows . . . . not down Emitter Bellows light barrier . . . . off <–> on 2) Light-barrier error 3) Emitter is off, detector is on	1) External light/stray light 2) Light-barrier emitter is defective - light-barrier detector is defective. 3) Light barrier response times for emitter and/or detector are greater than 20 ms. 4) SW 2.02 : Hardware for bellows detection not present, but configured in service mode "service 2".

31: Bellows leak test MA error codes (continued)		
0 0 0 8	1) ZV-O2/Air .... –> closed V3-N2O .... closed V7-tank-flush .... closed PV1-Prop .... open (12 L/min) V27-safety .... closed V28-safety - MV1-V1-Pmax-PEEP .... open (0 mbar) MV2-V2 time control .... closed MV3 control gas .... Auto MV5-AIR-O2 control gas Air/O2 MV6 A-cone .... internal F flow control .... 30 L/min Bellows .... down Emitter Bellows light barrier .... off <–> on 2) External light/stray light error 3) Emitter is off, detector is on	1) External light/stray light 2) Light barrier response times for emitter and/or detector are greater than 20 ms. 3) SW 2.02 : Hardware for bellows detection not present, but configured in service mode "service 2".
0 0 0 16	1) ZV1/3 (AIR/O2) .... -> closed V3-N2O .... closed V7-tank-flush .... closed PV1-Prop .... open (12 L/min) V27-safety .... closed V28-safety - MV1-V1-Pmax-PEEP .... open (0 mbar) MV2-V2 time control .... closed MV3 control gas .... Auto MV5-Air-O2 control gas Bellows .... down Emitter bellows light barrier off <–> on 2) Ventilation bellows error 3) Emitter is on, detector is on	1) Bellows has not reached bottom position because it is either absent or fitted incorrectly. 2) SW 2.02 : Hardware for bellows detection not present, but configured in service mode "service 2". User interaction: Test must be repeated

54.38 Test no. 32 (MA): System volume compliance

32: System volume compliance MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 0 0 4	1) ZV1-3 (AIR/N2O/O2) . -> closed V7-tank-flush . . . . -> open V10-prop . . . . -> open (12 L/min) V27-safety . . . . -> closed V28-safety MV1-V1-Pmax PEEP . . . . -> open (0 mbar) MV2-V2 time control . . . . -> closed MV3 control gas. . . . . -> Auto MV5-AIR-O2 control gas ->AIR/O2 MV6 A-cone . . . . -> internal F flow control 2) Paw is not equal to . . . . . ambient pressure 3) Paw . . . . > 4 mbar; . . . . time-out after 10 s	
0 0 0 8	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush . . . . open V10-prop . . . . open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Paw is not equal to ambient pressure 3) Paw > 5 mbar for 0.5 s	

32: System volume compliance MA error codes (continued)		
0 0 0 16	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush . . . . open --> closed V10-prop . . . . open (12 L/min) . . . . --> closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) . . . . --> closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Paw is not equal to ambient pressure 3) Paw . . . . > 5 mbar for 0.5 s	
0 0 0 32	1) ZV1/3 (AIR/O2). . . . . closed <--> open ZV2 (N2O) . . . . closed V7-tank-flush . . . . closed V10-prop . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Ptank does not reach working pressure 3) Ptank . . . . <= (P0 +900 mbar); . . . . time-out after 3 s	1) Pipeline supply insufficient. 2) Carry out flow calibration of pipeline inlet valves. See repair information (chapter 11.3 "CS System Inlet Valves Flow Calibration" in the Pneumatics Repair Instructions).

32: System volume compliance MA error codes (continued)		
0 0 0 64	1) ZV1/3 (AIR/O2). . . . . closed <–> open ZV2 (N2O) . . . . closed V7-tank-flush . . . . closed V10 prop . . . . closed (0 L/min) –> 5 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Paw does not reach start test pressure 3) Paw . . . . < 5 mbar; . . . . time-out after 3 s	1) Leakage in breathing system. 2) Check V10 flow rate accordin g to Test Certificat e. 3) Check PEEP valve in service mode. 4) Check PawV in service mode
0 0 0 128	1) ZV1/3 (AIR/O2). . . . . closed <–> open ZV2 (N2O) . . . . closed V7-tank-flush . . . . closed V10-prop . . . . 5 L/min V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Paw does not reach stop test pressure 3) Paw . . . . < (Paw (start) + 30 mbar) (Paw (start) . . . . > = 5 mbar); . . . . time-out after 5 s	1) Leakage in breathing system. 2) Check V10 flow rate accordin g to Test Certificat e. 3) Check PEEP valve in service mode. 4) Check PawV in service mode.

32: System volume compliance MA error codes (continued)		
0 0 1 0	1) ZV1/3 (AIR/O2) (closed <-> open) -> closed ZV2 (N2O) . . . . closed V7-tank-flush . . . . closed V10 prop . . . . 5 L/min -> closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Measured compliance is too high 3) C > 9.99 mL/mbar (default compliance = 5.00 mL/mbar)	1) Leakage in breathing system. 2) Man/Spont switchover valve in breathing system is defective 3) Check PawV sensor.
0 0 2 0	1) ZV1/3 (AIR/O2) . . . . (closed <-> open) -> closed ZV-N2O . . . . closed V7-tank-flush . . . . closed V10 prop . . . . 5 L/min -> closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Measured compliance is too low 3) C < 4.00 mL/mbar (default compliance = 5.00 mL/mbar)	1) Check V10 flow rate. 2) Check PawV sensor in service mode.
0 0 4 0	1) ZV1/3 (AIR/O2) (closed <-> open) -> closed ZV2 (N2O) . . . . closed V7-tank-flush . . . . closed V10 prop . . . . 5 L/min -> closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Measured leak rate is too high 3) L > 150 mL/min (leak rates > 999 mL/min are "fixed" to 999 mL/min)	1) Leakage in breathing system. 2) Leakage at the interface to the breathing system.

32: System volume compliance
MA error codes (continued)

0 0 8 0	1) ZV1/3 (AIR/O2) (closed <-> open) -> closed ZV2 (N2O) . . . . closed V7-tank-flush . . . . closed V10-prop 5 L/min . . . . . . -> closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . closed (70 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control 2) Measured leak rate is "negative", that is, the measured start test pressure is lower than the measured stop test pressure (the stop test pressure of the previous compliance measurement is used as measured start test pressure) 3) Paw (Start) - Paw (stop) . < - 5 mbar 4) Test procedure: Connect pipeline supply and connect flowmeter to fresh-gas outlet (second connector from left). Start service mode. V7 EDOS test in position "open". Flow > 50 mL/min -> flush-button leakage Flow < 50 mL/min -> V28 in position "open" and check leak flow. Flow > 50 mL/min -> V27 leakage Flow < 50 mL/min -> V7 in position "closed". Fill reservoir until Ptank indicates approx 2000 mbar. Flow > 50 mL/min -> Differential pressure sensor Pfgf on Pressure Sensor PCB at EDOS block has probably an offset drift. Flow < 50 mL/min -> Connect flowmeter to driving flow connector (center connector). Select ventilator test from service menu. MV2 in position "closed". Flow > 50 mL/min -> Leakage at MV2	1) Leak flow into the system. 2) Test procedur e accordin g to item 4

54.39 Test no. 33 (MA): Y-piece

33: Y-piece MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 0 0 4	1) ZV1-3 (AIR/N2O/O2) . . . -> closed V7-tank-flush. . . . .-> open V10-prop . . . .-> open (12 L/min) V27-safety . . . .-> closed V28-safety MV1-V1-Pmax PEEP . . . . .-> open (0 mbar) MV2-V2 time control . . . .-> closed MV3 control gas . . . .->Auto MV5-AIR-O2 control gas .->AIR/O2 MV6 A-cone . . . . internal F flow control 2) Paw is not constant (at P0) 3) ΔPaw . . . . > 4 mbar; . . . . .time-out after 10 s	
0 0 0 8	1) ZV1-3 (AIR/N2O/O2) . . .closed V7-tank-flush. . . . . open V10-prop . . . . .open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . .open (0 mbar) MV2-V2 time control . . . .closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control 2) Paw is not constant (at P0) 3) ΔPaw . . . .> 5 mbar for 0.5 s	

33: Y-piece MA error codes (continued)		
0 0 0 16	1) ZV1-3 (AIR/N2O/O2) . . .closed V7-tank-flush open. . . . . . . –> closed V10-prop . . . . .open (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . .closed (70 mbar) MV2-V2 time control . . . .closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . internal F flow control 2) Paw is not constant (at P0) 3) ΔPaw . . . .> 5 mbar for 0.5 s	
0 0 8 0	1) ZV1/3 (AIR/O2) . . . . closed <–> open ZV2 (N2O) . . . . .closed V7-tank-flush. . . . . .closed V10 . . . . .12 L/min V27-safety . . . . closed V28-safety. . . . .- MV1-V1-Pmax PEEP . . . .70 mbar MV2-V2 time control . . . .closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas .Air/O2 MV6 A-cone . . . . .internal F flow control . . . .- 2) Paw does not reach test pressure 3) Paw . . . .< P0 + 60 mbar; . . . . .time-out after 5 s (neither with O2 nor with Air)	1) Y-piece is open. 2) No Air and no O2, Pressures are too low 3) V10 does not open (<<12 L/min), (–> flowmeter) 4) ZV1/3 (AIR/O2) do not open or open too slowly 5) V7-tank-flush does not close 6) MV1-V1-Pmax PEEP < 60 mbar 7) PSI valve < 60 mbar 8) System leaky (e.g. no flow sensor) 9) Paw defective

54.40 Test no. 34 (MA): Y-piece F flow control

34: Y-piece F flow control MA error codes		
(pay attention to possible superposition of (common) bits 0,1,2; F flow control has priority (see evaluate_cold_tests –> post.c) !!!)		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	1) - 2) No test result (reset) 3) -	
0 0 0 1	1) - 2) Abort 3) -	
0 0 0 2	1) - 2) o.k. 3) P9-tank . . . .<= (P0 + 60 mbar); . . . . .Time-out/test end after 20 s	
0 0 0 4	1) ZV1-3 (AIR/N2O/O2) . . .–> closed V7-tank-flush . . . .–> open PV1-prop . . . . 12 L/min V27-safety . . . .–> closed V28-safety . . . .–> closed MV1-V1-Pmax PEEP . . . .–> open (0 mbar) MV2-V2 time control . . . .–> closed MV3 control gas . . . . –> Auto MV5-AIR-O2 control gas .–> Air/O2 MV6 A-cone . . . .–> internal F flow control . . . .–>? 2) Reservoir pressure does not reach ambient pressure within 10 s 3) P9-tank > (P0 + 50 mbar); time-out after 10 s	1) Previous reservoir pressure was too high, V3 stuck in position "open", O_2+ stuck in position "open" / was operated Safety-flow proportioner was opened. 2) V7 stuck in position "closed"

34: Y-piece F flow control MA error codes (continued)		
0 0 0 8	1) (as ..._PRE_01) 2) Reservoir pressure does not remain at ambient pressure for 0.5 s 3) P9-tank > (P0 + 60 mbar)	1) Reservoir pressure increases, O_2+ was operated Safety-flow proportioner was opened.
0 0 2 0	1) - 2) Safety-flow proportioner is pneumatically opened 3) (see ..._Ptank0!)	
0 0 16 0	1) V7-tank-flush . . . . -> closed MV1-V1-Pmax PEEP . . . .-> closed (70 mbar) 2) Reservoir pressure. . . . . .does not remain for 20 s . . . . .at ambient pressure 3) P9-tank. . . . . > (P0 + 60 mbar) (always in combination with ..._OPENED!)	1) Reservoir pressure increases Safety-flow proportioner is open V3 or O_2+ leaky.
0 0 32 0	1) 2) Airway pressure does not remain at ambient pressure 3) Paw > (P0 + 15 mbar)	1) V3, O_2+ or safety-flow proportioner leaky, Deviation corresponds to a leak rate of approx. 300 mL/min at a system compliance of 6 mL/mbar.
0 1 0 0	1) V7-tank-flush . . . . -> closed MV1-V1-Pmax PEEP . . . . -> closed (70 mbar) 2) Safety-flow proportioner electrically opened 3) P9-tank <= (P0 + 60 mbar), Status safety-flow proportioner shows OPEN time-out after 20 s	1) Safety-flow proportioner is opened slightly 2) Safety-flow proportioner is adjusted incorrectly.

34: Y-piece F flow control MA error codes (continued)		
0 2 0 0	1) V7-tank-flush . . . . -> closed MV1-V1-Pmax PEEP . . . . -> closed (70 mbar) 2) Safety-flow proportioner is pneumatically opened, but electrically closed 3) P9-tank > (P0 + 60 mbar), Status safety-flow proportioner shows CLOSED (in combination with ..._OPENED)	1) Safety-flow proportioner is opened slightly 2) Safety-flow proportioner is adjusted incorrectly. 3) Safety-flow proportioner is configured incorrectly and V3, O_2%, or V27 and V28 are leaky
0 4 0 0	1) Varies according to other errors 2) Monostable SAFETY flow valve (V27) is connected. 3) V27 status shows CLOSED (as additional information to other messages)	1) Wrong configuration 2) Wrong hardware conversion
0 8 0 0	1) Varies according to other errors V28-safety . . . .-> open -> closed 2) Bistable SAFETY flow valve (V28) is connected. 3) V28-STATUS shows OPEN (as additional information to other messages)	1) Wrong configuration 2) Wrong hardware conversion
0 16 0 0	1) Varies according to other errors 2) Safety-flow proportioner electrically opened 3) Safety-flow proportioner status shows OPEN (as additional information to other messages)	
0 32 0 0	1) Varies according to other errors 2) Safety-flow proportioner is closed electrically 3) Safety-flow proportioner status shows CLOSED (as additional information to other messages)	

54.41 Test no. 34 (SV): Y-piece F flow control

34: Y-piece F flow control SV error codes		
(pay attention to possible superposition of (common) bits 0,1,2; F flow control has priority (see evaluate_cold_tests -> post.c) !!!)		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	1) - 2) No test result (reset) 3) -	
0 0 0 1	1) - 2) Abort 3) -	
0 0 0 2	1) - 2) o.k. 3) Safety-flow proportioner status shows CLOSED	1) Safety-flow proportioner is closed 2) Safety-flow proportioner light barrier adjusted incorrectly 3) Safety-flow proportioner is not connected (wrong configuration)
0 1 0 0	1) - 2) Safety-flow proportioner is opened electrically 3) Safety-flow proportioner status shows OPEN	1) Safety-flow proportioner is open 2) Safety-flow proportioner light barrier adjusted incorrectly
0 16 0 0	1) - 2) Safety-flow proportioner is opened electrically 3) Safety-flow proportioner status shows OPEN	1) Safety-flow proportioner is open 2) Safety-flow proportioner light barrier adjusted incorrectly

34: Y-piece F flow control SV error codes (continued)		
0 32 0 0	1) - 2) Safety-flow proportioner is closed electrically 3) Safety-flow proportioner status shows CLOSED	1) Safety-flow proportioner is closed 2) Safety-flow proportioner light barrier adjusted incorrectly 3) Safety-flow proportioner is not connected (wrong configuration)

54.42 Test no. 35 (MA): High pressure Pvor

35: High pressure Pvor MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	

35: High pressure Pvor MA error codes (continued)		
0 0 0 4	1) ZV1-3 (AIR/N2O/O2) V7-tank-flush V10-prop . . . . -> closed (0 L/min) V27-safety . . . . -> closed V28-safety MV1-V1-Pmax PEEP . . . . -> open (0 mbar) MV2-V2 time control . . . . -> closed MV3 control gas. . . . . -> Auto MV5-AIR-O2 control gas ->AIR/O2 MV6 A-cone . . . . -> internal F flow control . . . . -> 20 L/min 2) Pvor is not constant 3) Pvor......................> 100 mbar; time-out after 10 s	1) Check Pvor sensor in service mode.
0 0 0 8	1) ZV1-3 (AIR/N2O/O2) V7-tank-flush V10-prop . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control . . . . 20 L/min 2) Pvor is not constant 3) Pvor.........................> 150 mbar for 0.5 s	

35: High pressure Pvor MA error codes (continued)		
0 0 0 16	1) ZV1-3 (AIR/N2O/O2) V7-tank-flush V10-prop . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . . closed -> open MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control . . . . 20 L/min 2) Pvor is too low 3) Pvor . . . . < 1400 mbar for 1 s	1) Pressure regulator Pvor adjusted incorrectly. 2) Check Pvor sensor and pressure increase at Pvor in service mode while MV2 is open. Delta Pvor = 1800 ± 100 mbar
0 0 0 32	1) ZV1-3 (AIR/N2O/O2) V7-tank-flush V10-prop . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . . open MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control . . . . 20 L/min 2) Pvor too high 3) Pvor . . . . > 2300 mbar for 1 s	

54.43 Test no. 35 (SV): High pressure Pvor

35: High pressure Pvor SV error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	

35: High pressure Pvor SV error codes (continued)		
0 0 0 2	- o.k. -	
0 0 0 4	1) Configuration of pneumatics by the MA 2) (Electrical) valve status of MV2-V2 time control is "closed" and/or Pvor is outside permissible range 3) (Electrical) valve status of MV2-V2 time control is "closed"; time-out after 20 s and/or Pvor - 1800 mbar > 200 mbar; time-out after 20 s	1) Ventilator is defective
0 0 0 8	1) Configuration of pneumatics by the MA 2) (Electrical) valve status of MV2-V2 time control is "closed" and/or Pvor is outside permissible range 3) (Electrical) valve status of MV2-V2 time control is "closed" after 1 s and/or Pvor - 1800 mbar > 200 mbar after 1 s	
0 0 0 16	1) Configuration of pneumatics by the MA 2) Pvor calibration error 3) Pvor - 1800 mbar > 150 mbar (to be described in more detail; –> vnt_p_m.c)	
0 0 0 32	1) Configuration of pneumatics by the MA 2) Pvor (MA) is outside permissible range 3) Pvor (MA) - 1800 mbar > 200 mbar; time-out after 20 s	

54.44 Test no. 36 (MA): EDOS emergency stop

36: EDOS emergency stop MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	

36: EDOS emergency stop MA error codes (continued)		
0 0 0 2	- o.k. -	
0 0 0 4	1) ZV1-3 (AIR/N2O/O2) . . .-> closed V7-tank-flush. . . . .-> open V10-prop. . . . . -> closed (0 L/min) V27-safety . . . .-> closed V28 safety . . . .-> open MV1-V1-Pmax PEEP. . . . .-> open (0 mbar) MV2-V2 time control . . . .-> closed MV3 control gas . . . .-> Auto MV6 A-cone . . . .-> internal F flow control 2) Ptank . . . . .is not constant 3) ΔPtank . . . . > 50 mbar; . . . . .time-out after 10 s	
0 0 0 8	1) ZV1-3 (AIR/N2O/O2) . . .closed V7-tank-flush. . . . . open V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety . . . . open MV1-V1-Pmax-PEEP . . . .open (0 mbar) MV2-V2 time control . . . .closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control 2) Ptank is not constant 3) ΔPtank . . . . > 60 mbar for 0.5 s	
0 0 0 16	1) ZV1-3 (AIR/N2O/O2) . . .closed V7-tank-flush . . . . open –> closed V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety . . . . open MV1-V1-Pmax-PEEP . . . .open (0 mbar) . . . .–> closed . . . .(70 mbar) MV2-V2 time control . . . .closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control 2) Ptank is not constant 3) ΔPtank . . . .> 60 mbar for 0.5 s	1) Gas proportioner is defective (prerequisite)

36: EDOS emergency stop MA error codes (continued)		
0 0 0 32	1) ZV1/3 (AIR/O2) . . . . closed --> open V3-(N2O) . . . . closed V7-tank-flush. . . . . .closed V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety . . . . open MV1-V1-Pmax-PEEP . . . . .closed (70 mbar) MV2-V2 time control . . . .closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control 2) Ptank is too low 3) Ptank . . . .<= P0 + 1000 mbar; . . . . .time-out after 3 s	1) Se repair information (chapter 11.3 "CS System Inlet Valves Flow Calibration" and 11.5 "EDOS Leak Test" in the Pneumatics Repair Instructions).
0 0 0 64	1) ZV1/3 (AIR/O2) . . . . . .open V3-(N2O) . . . . closed V7-tank-flush. . . . . .closed V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety . . . . open MV1-V1-Pmax-PEEP . . . . .closed (70 mbar) MV2-V2 time control . . . .closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control 2) Ptank does not reach ambient pressure 3) Ptank - P0 < 100 mbar; time-out after 10 s	1) Carry out flow calibration of pipeline inlet valves. See repair information (chapter 11.3 "CS System Inlet Valves Flow Calibration" in the Pneumatics Repair Instructions). 2)V4 switchover to auto operation is faulty (switchover diaphragm in patient system?). 3) V7 does not open. Check in service mode. Silicone tubing at outlet of V7 to AGS buckled. 4) Supervisor cannot switch off relay (voltage supply to EDOS). Probably. Ventdos-Controller PCB hardware fault.

36: EDOS emergency stop MA error codes (continued)		
0 0 0 128	1) ZV1/3 (AIR/O2) . . . . open –> closed V3-(N2O) . . . . closed V7-tank-flush. . . . . .closed V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety . . . . open MV1-V1-Pmax-PEEP . . . . .closed (70 mbar) MV2-V2 time control . . . .closed MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control 2) Paw . . . . .is too low 3) (Current) Paw - Paw (P0) < 10 mbar; time-out after 10 s	Gas proportioner is defective 1) V27-safety has not opened. 2) V28-safety is closed 3) Safety flow is too low 4) Breathing system is leaky

54.45 Test no. 36 (SV): EDOS emergency stop

36: EDOS emergency stop SV error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 0 0 4	1) Configuration of pneumatics by the MA 2) Ptank is not constant 3) ΔPtank > 100 mbar; time-out after 10 s	Gas proportioner is defective (prerequisite)

36: EDOS emergency stop SV error codes (continued)		
0 0 0 8	1) Configuration of pneumatics by the MA 2) Ptank does not reach "stop test pressure" 3) Ptank < 2250 mbar; time-out after 5 s	Gas proportioner is defective (prerequisite)
0 0 0 16	1) Configuration of pneumatics by the MA 2) Ptank is not equal to ambient pressure and/or Paw does not reach test pressure (due to "safety") 3) ΔPtank > 100 mbar; time-out after 10 s and Paw - Paw (P0) < 10 mbar; time-out after 10 s	Gas proportioner is defective Valve plate M 33940 is defective

54.46 Test no. 37 (MA): Ventilator emergency stop

37: Ventilator emergency stop MA error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	

37: Ventilator emergency stop
MA error codes (continued)

0 0 0 4	1) ZV1-3 (AIR/N2O/O2) . . -> closed V7-tank-flush. . . . . -> open V10-prop . . . . -> open (12 L/min) V27-safety . . . . -> closed V28-safety MV1-V1-Pmax PEEP . . . . -> open (0 mbar) MV2-V2 time control . . . -> closed MV3 control gas . . . . -> Man/Spont MV5-AIR-O2 control gas ->AIR/O2 MV6 A-cone . . . . -> internal F flow control . . . . -> 20 L/min 2) Paw higher than APL pressure including tolerance 3) Paw > (30 + 10) mbar; time-out after 60 s	Ventilator is defective (prerequisite)
0 0 0 8	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush. . . . . open V10-prop . . . . open (12 L/min) . . . . -> closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . closed MV3 control gas . . . . Man/Spont MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control . . . . 20 L/min 2) Paw higher than APL pressure including tolerance 3) Paw > (30 + 10 + 5) mbar; for 0.5 s	Ventilator is defective (prerequisite)
0 0 0 16	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush. . . . . open V10-prop . . . . open (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . closed MV3 control gas . . . . Man/Spont --> Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control . . . . 20 L/min 2) Paw too high 3) Paw . . . . > 4 mbar; . . . . time-out after 10 s	Ventilator is defective (prerequisite)

37: Ventilator emergency stop MA error codes (continued)		
0 0 0 32	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush. . . . . open V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) MV2-V2 time control . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control . . . . 20 L/min 2) Paw too high 3) Paw . . . . > 5 mbar . . . . for 0.5 s	Ventilator is defective (prerequisite)
0 0 0 64	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush. . . . . open V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . open (0 mbar) . . . . –> closed (70 mbar) MV2-V2 time control . . . closed MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control . . . . 20 L/min 2) Paw too high 3) Paw . . . . > 5 mbar . . . . for 0.5 s	Ventilator is defective (prerequisite)
0 0 0 128	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush. . . . . open V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . closed (70 mbar) MV2-V2 time control . . . closed - -> open MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control . . . . 20 L/min 2) Paw too low 3) Paw . . . . <= 50 mbar . . . . for 5 s	Ventilator is defective (prerequisite)

37: Ventilator emergency stop MA error codes (continued)		
0 0 1 0	1) ZV1-3 (AIR/N2O/O2) . . closed V7-tank-flush. . . . . open V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . closed (70 mbar) MV2-V2 time control . . . open MV3 control gas . . . . Auto MV5-AIR-O2 control gas AIR/O2 MV6 A-cone . . . . internal F flow control . . . . 20 L/min 2) Paw greater than/equal to APL pressure including tolerances 3) Paw >= (30 + 10 + 5) mbar; time-out after 10 s	Ventilator is defective 1) Relay for ventilator has not switched off at all or not fast enough; MV1 - Pmax-PEEP, MV2-timecontrol, MV3-control gas have not reached their normal status (Man/Spont mode).

54.47 Test no. 37 (MA and SV): Ventilator emergency stop

37: Ventilator emergency stop SV error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	

37: Ventilator emergency stop SV error codes (continued)		
0 0 0 4	Configuration of pneumatics by the MA 1) ZV1-3 (AIR/N2O/O2) . . .closed V7-tank-flush. . . . . open V10-prop. . . . . closed (12 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . .closed (0 mbar) MV2-V2 time control . . . .closed MV3 control gas . . . . .Man/Spont MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control . . . . .20 L/min 2) (Electrical) status of MV3 control gas does not reach Man/Spont 3) MV3 control gas status . .<> Man/Spont; . . . . .time-out after 70 s	Ventilator is defective (prerequisite) 1) MA has not switched MV3 control gas to Man/Spont 2) SV detects wrong (electrical) status of MV3 control gas
0 0 0 8	Configuration of pneumatics by the MA 1) ZV1-3 (AIR/N2O/O2) . . .closed V7-tank-flush. . . . . open V10-prop . . . . .open (12 L/min) . . . . –> closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . .open (0 mbar) . . . .–> closed (70 mbar) MV2-V2 time control . . . . closed –> open MV3 control gas . . . . .Man/Spont –> Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control . . . . .20 L/min 2) Paw too low 3) Paw . . . .<= 60 mbar; . . . . .time-out after 10 s	Ventilator is defective (prerequisite) Breathing system is leaky in the "auto branch" (e.g. due to Y-piece)

37: Ventilator emergency stop **SV error codes (continued)**		
0 0 0 16	Configuration of pneumatics by the MA 1) ZV1-3 (AIR/N2O/O2) . . .closed V7-tank-flush. . . . . open V10-prop. . . . . closed (0 L/min) V27-safety . . . . closed V28-safety MV1-V1-Pmax-PEEP . . . . .closed (70 mbar) MV2-V2 time control . . . .open MV3 control gas . . . . .Auto MV5-AIR-O2 control gas . AIR/O2 MV6 A-cone . . . . .internal F flow control . . . . .20 L/min 2) Paw greater than/equal to 3) APL pressure including tolerance >= (30 + 10 + 5) mbar; . . . . .time-out after 10 s	Ventilator is defective 1) Relay for ventilator has not switched off fast enough; MV1-Pmax-PEEP, MV2-timecontrol, MV3 control gas have not reached their "normal status" (Man/Spont mode).

54.48 Test no. 38 (MA): Fan

38: Fan **MA error codes**		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 0 0 16	- Wrong test sequence -	1) Ventilator fan is defective.

54.49 Test no. 38 (SV): Fan

38: Fan SV error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 0 0 4	1) Switch off fan control through MA 2) Fan cannot be switched on. 3) Time-out after 10 s	1) Ventdos-Controller PCB/Actuator PCB is faulty.
0 0 0 8	1) Switch on fan control through MA 2) Fan cannot be switched on. 3) Time-out after 10 s	1) Ventdos-Controller PCB/Actuator PCB is faulty.
0 0 0 16	- Wrong test sequence -	1) Ventilator is defective

54.50 Test no. 39 (MA): Synchronize VentDos with SC

54.51 Test no. 40 (MA): Test abort is possible

54.52 Test no. 50 (MA): Electronic test start

54.53 Test no. 59 (MA): Electronics test end

54.54 Test no. 60 (MA): Flow control test start

54.55 Test no. 69 (MA): Flow control test end

54.56 Test no. 70 (MA): Ventilation test start

54.57 Test no. 71 (MA): IIPPV/Compl./leak test start

54.58 Test no. 72 (MA): IPPV/Compl./leak test end

54.59 Test no. 73 (MA): Leak test request ("Leak test" request to monitor)

During this phase, VentDos is waiting for a "release signal" from the monitor; possible problems in monitor or Iria:

– no "pump off signal" from Iria to monitor

– no oxygen cell

– sample gas return line is obstructed/buckled in VentDos pneumatics

Note: IRIA status byte in service mode

54.60 Test no. 74 (MA): Leak test end

54.61 Test no. 79 (MA): Ventilator test end

54.62 Test no. 80 (MA): Adjust F flow control to 20 L/min

This test step is sometimes "misused" to send error code 11080 to the monitor if IniMode detects a flat backup battery.

54.63 Test no. 81 (SV): Check that F flow control is 20 L/min

81: Check that F flow control is 20 L/min SV error codes		
Display on the monitor (in decimal format)	1) Test environment 2) Test result 3) Explanation	Possible cause(s)
0 0 0 0	- No test result (reset) -	
0 0 0 1	- Abort -	
0 0 0 2	- o.k. -	
0 0 0 4	1) Previous slot-valve setting (F flow control) through MA at 20 L/min 2) SV light barriers 1 and 2 have detected wrong quadrant 3) SV light barrier 1 on SV light barrier 2 on **Note:** The exact combination is: SV light barrier 1 on SV light barrier 2 off Also permissible: SV light barrier 1 off SV light barrier 2 off	1) Light barriers of slot valves are faulty or Ventdos-Controller PCB is faulty.

81: Check that F flow control is 20 L/min SV error codes (continued)		
0 0 0 8	1) Previous slot-valve setting (F flow control) through MA at 20 L/min 2) SV light barriers 1 and 2 have detected wrong quadrant 3) SV light barrier 1 off SV light barrier 2 on **Note:** The exact combination is: SV light barrier 1 on SV light barrier 2 off Also permissible: SV light barrier 1 off SV light barrier 2 off	1) Light barriers of slot valves are faulty or Ventdos-Controller PCB is faulty.
0 0 0 16	- undefined quadrant -	

54.64 Test no. 90 (MA): POST log data to modules

54.65 Test no. 255 (MA and SV): All tests completed

Schematics and Diagrams

Contents

54.66 Julian pneumatics diagram

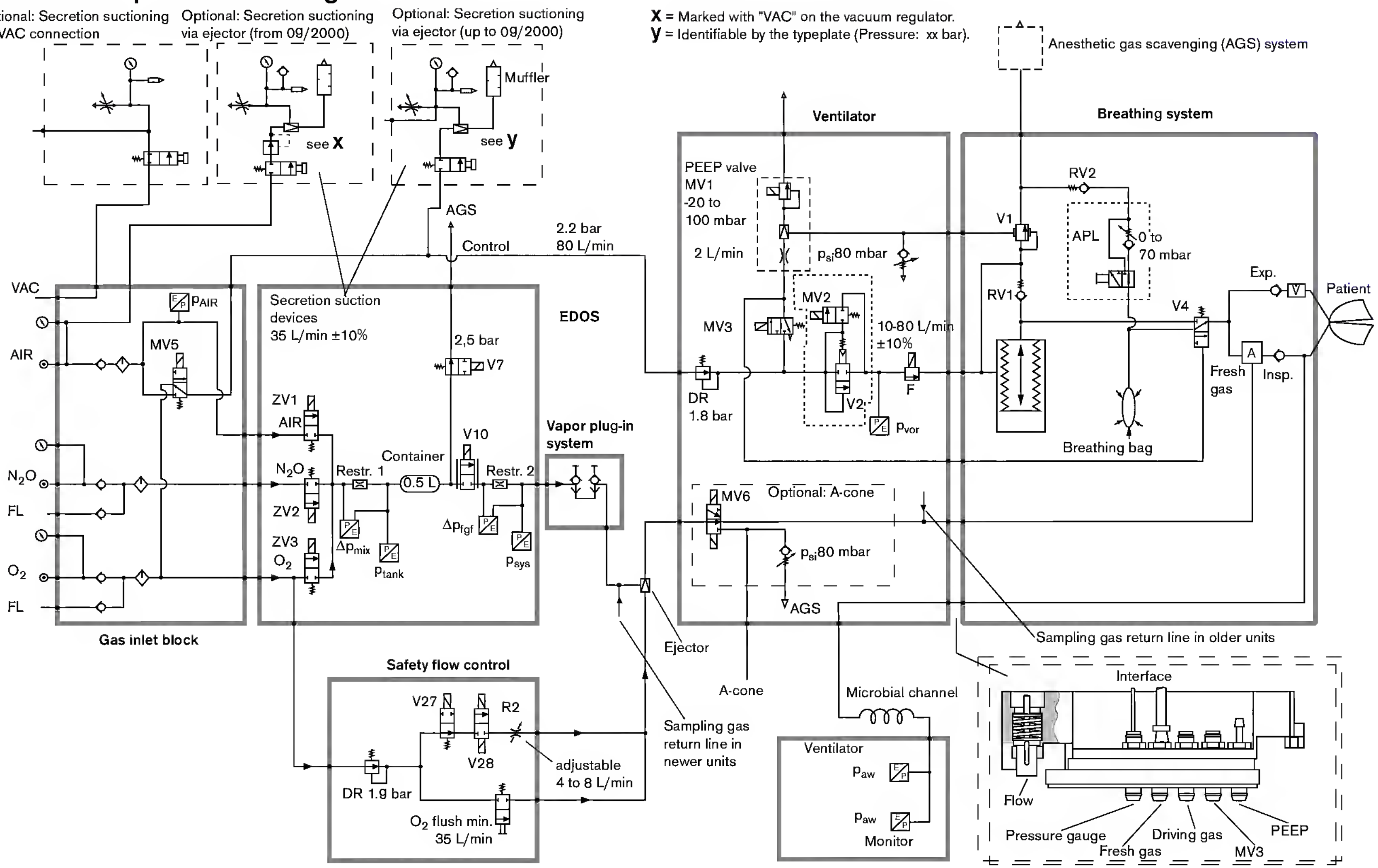


Fig.112: Julian pneumatics diagram

54.67 Julian pneumatics diagram (US version)

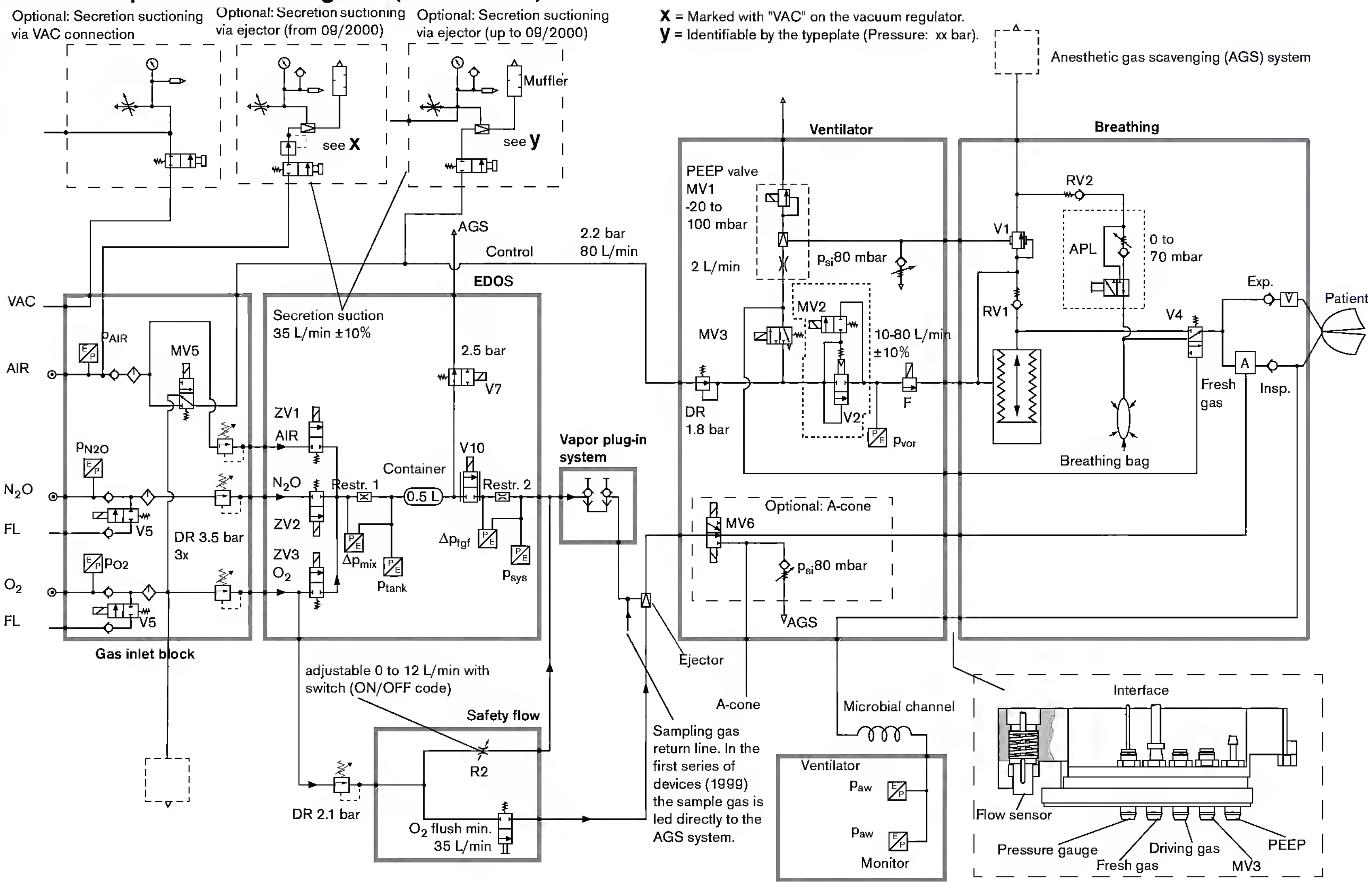


Fig.113: Julian pneumatics diagram (US version)

55 Tubing Diagram (with optional ejectors "International/France")

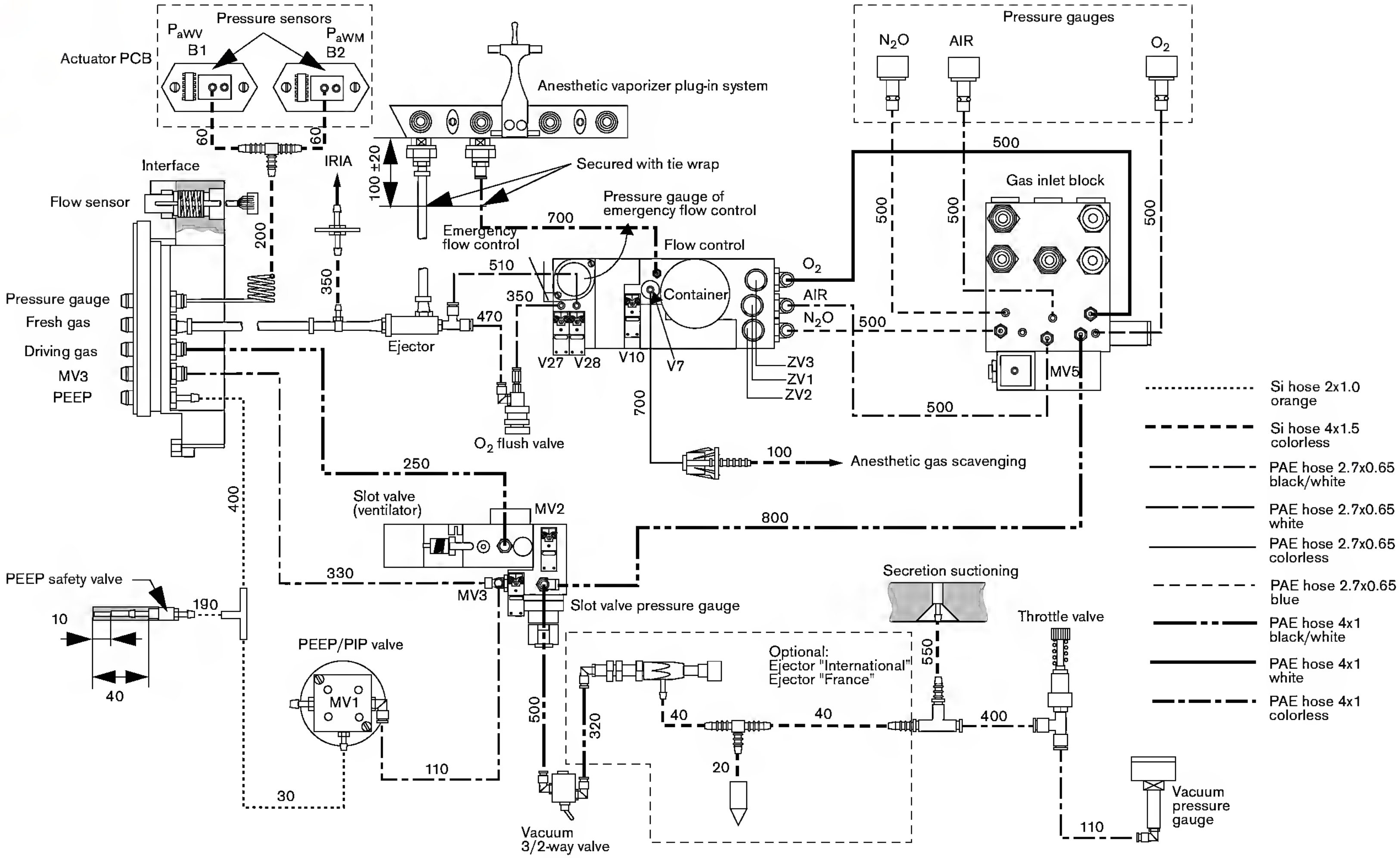


Fig.114: Tubing diagram (with optional ejectors "International/France")

56 Tubing Diagram (with optional A-cone and vacuum connection)

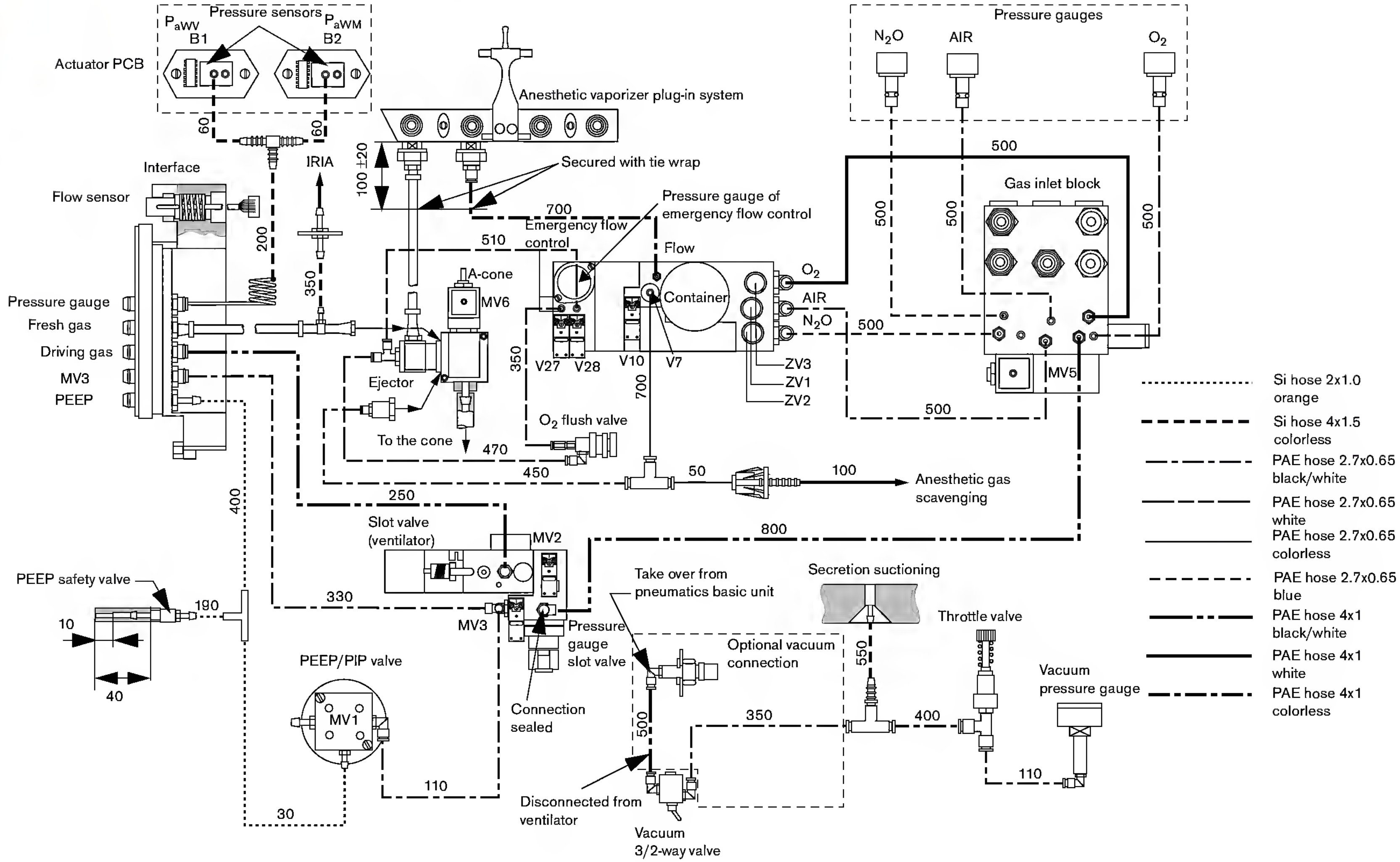


Fig.115: Tubing diagram (with optional A-cone and vacuum connection)

56.1 Tubing diagram with A-cone and vacuum connection as of 09/2000

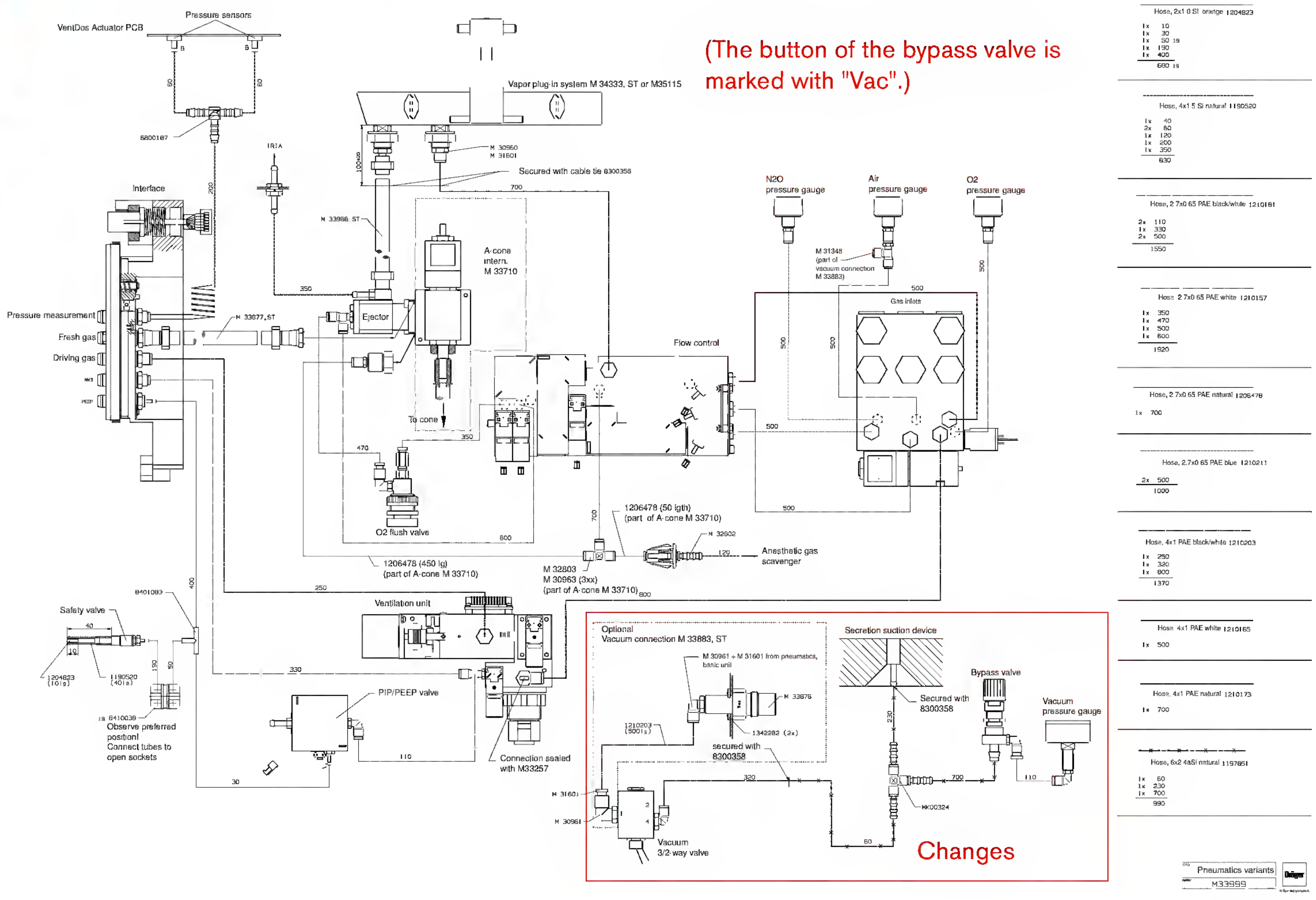


Fig.116: Tubing diagram with A-cone and vacuum connection

56.2 Tubing diagram with ejector (3.5 to 5.5 bar) as of 09/2000

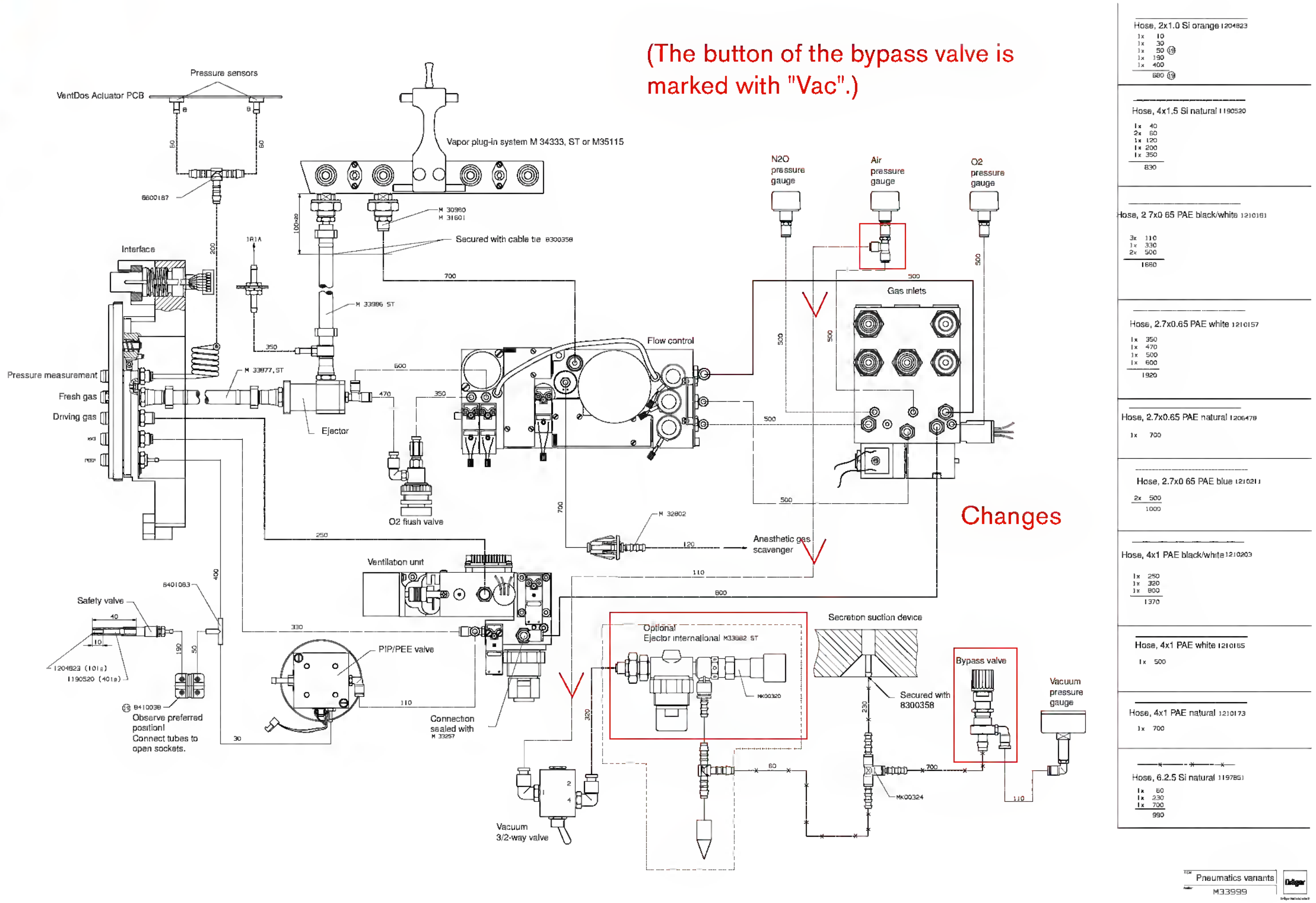


Fig.117: Tubing diagram with ejector (3.5 to 5.5 bar)

57 Overview of Julian components (rear panel removed)

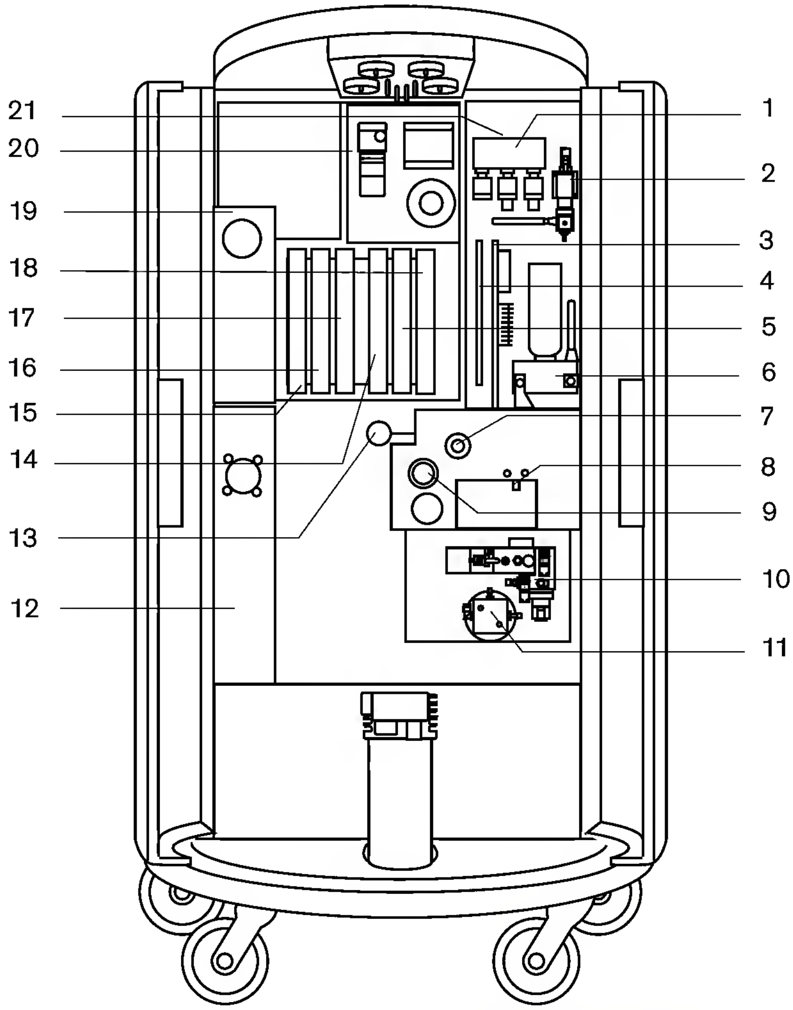


Fig.118: Rear view of Julian, cover removed (refer to "Table 5: Legend" for explanations)

Table 5: Legend

1	Gas inlet block	11	PEEP/PIP valve
2	A-cone (optional)	12	Powerpack with rechargeable battery
3	Actuator PCB	13	Ejector (secretion suction system)
4	Ventdos Controller PCB	14	SpO_2 PCB (optional)
5	free slot	15	Vitara PCB
6	EDOS	16	Front PCB
7	Valve V7 outlet	17	Measured Value PCB
8	Safety valve	18	CIO PCB
9	Anesthetic gas scavenging outlet	19	DC/DC converter
10	Slot valve	20	IRIA module
		21	EPI Controller PCB, EPI Display PCB at front (USA version)

58 Identification of Printed Circuit Boards

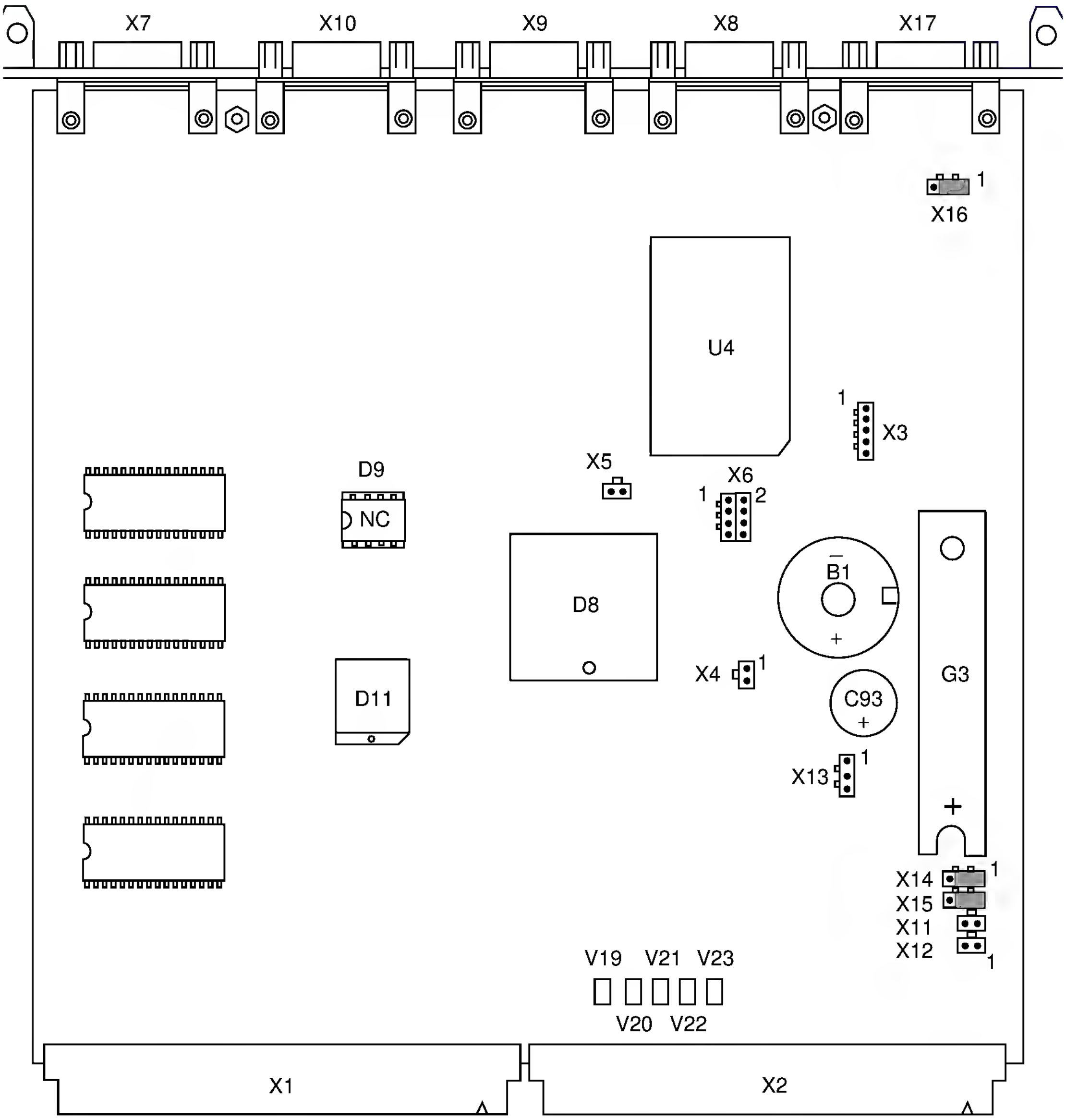


Fig.119: CIO PCB

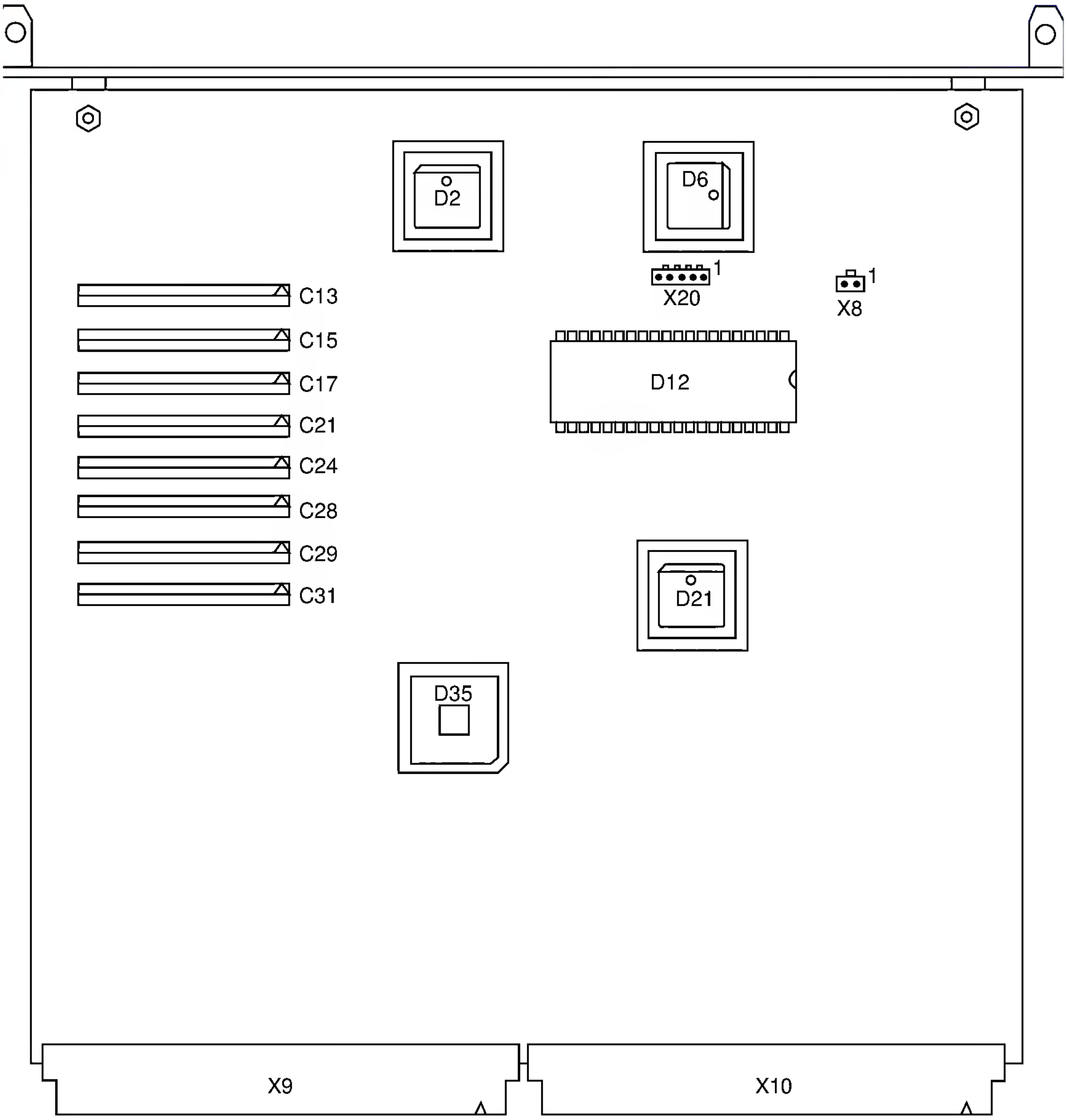


Fig. 120: Front PCB

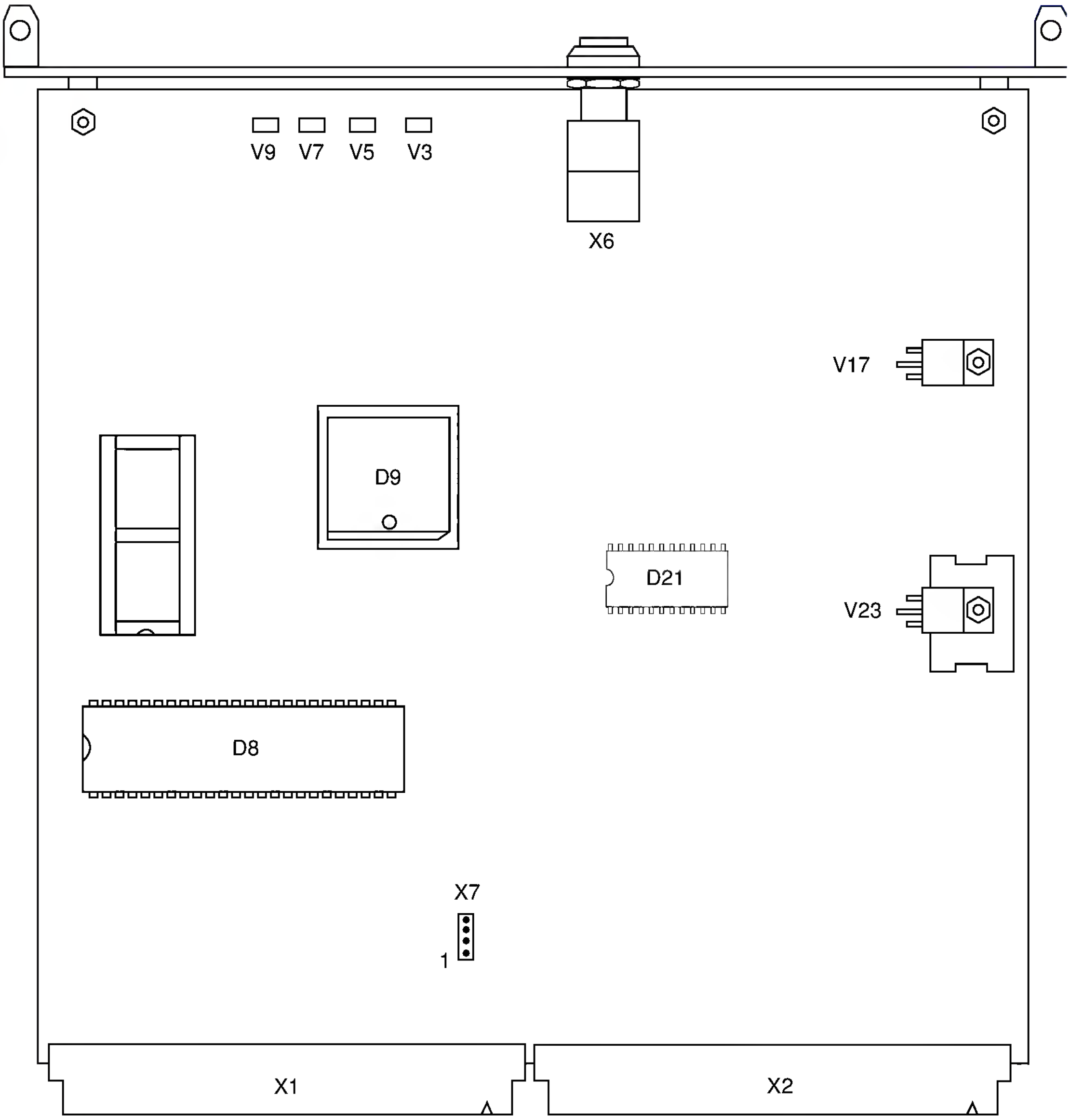


Fig. 121: Measured Value PCB

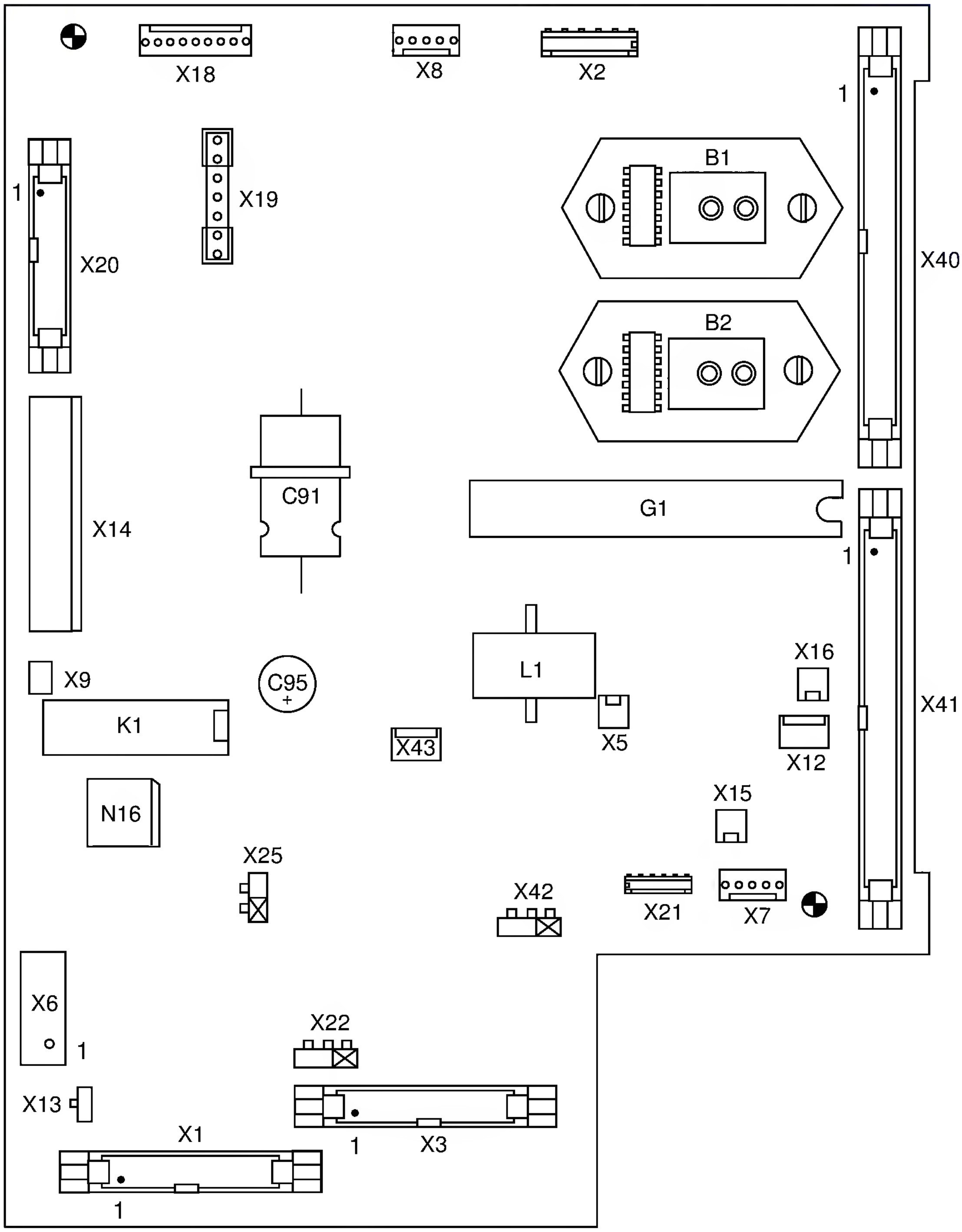


Fig.122: Actuator PCB

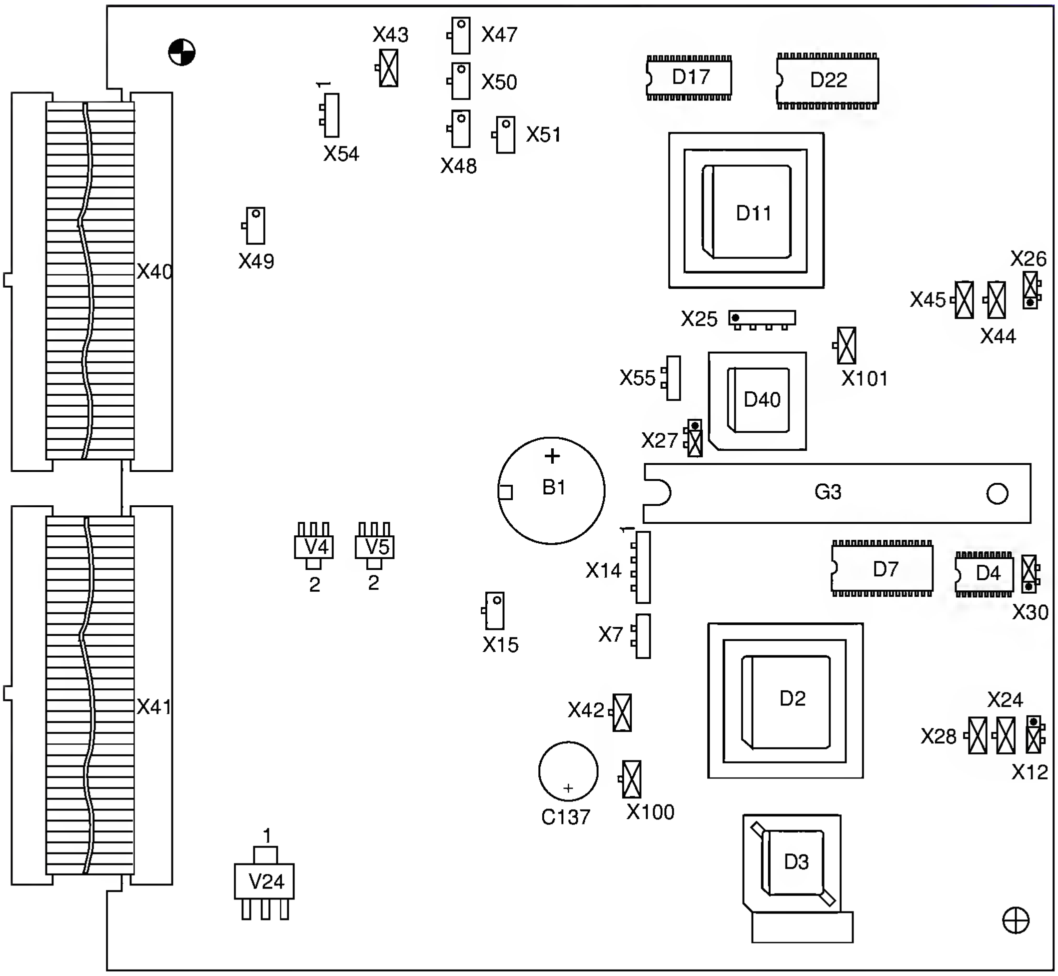


Fig. 123: Ventdos Controller PCB

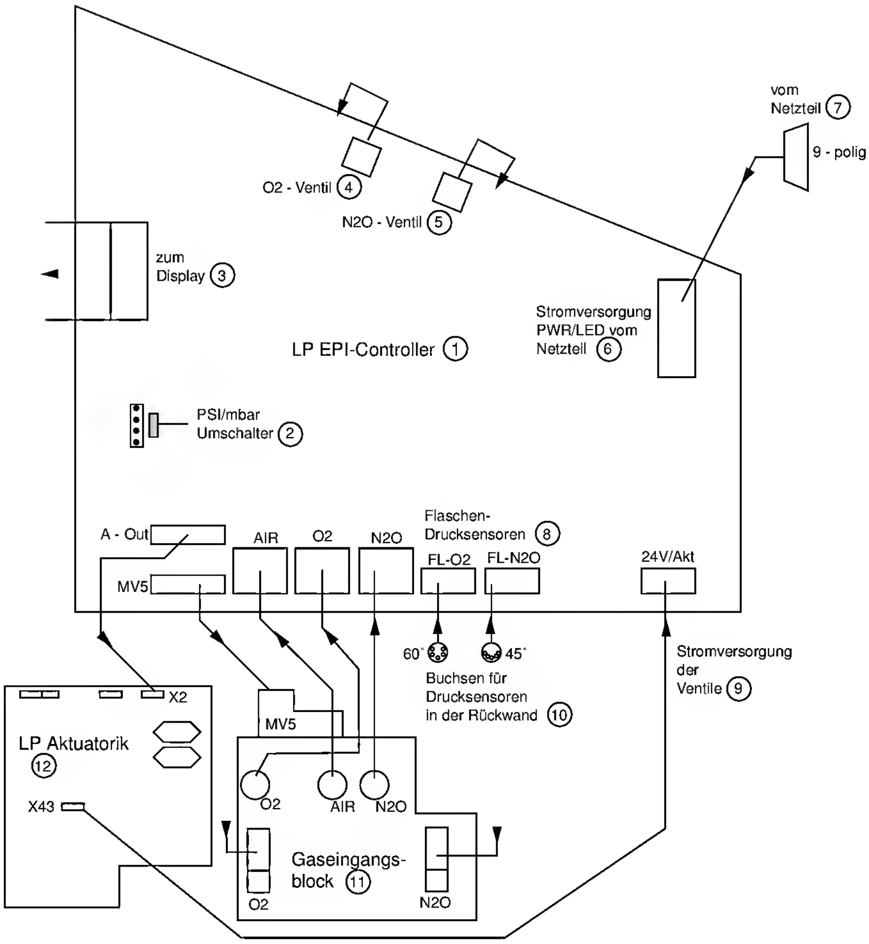


Fig.124: EPI Controller PSB , Actuators PCB and gas inlet block (USA version)

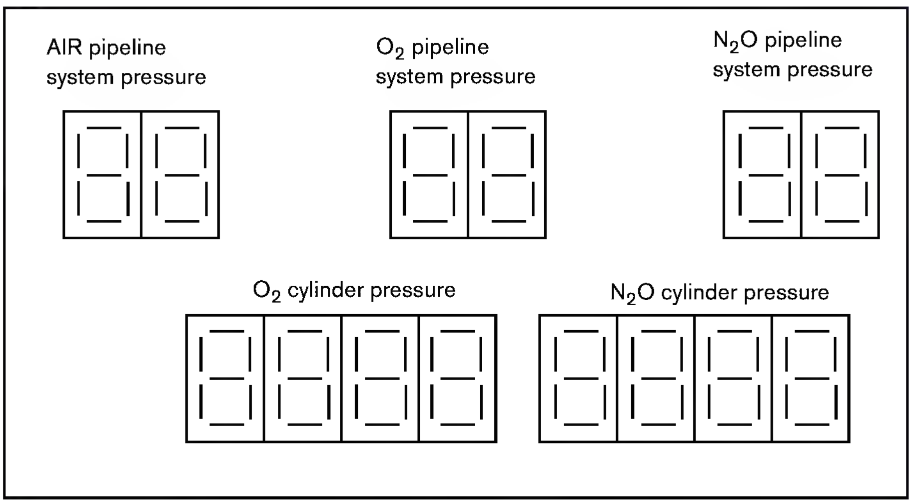


Fig.125: EPI Display PCB (USA version)

59 Tubing Diagram (US Version)

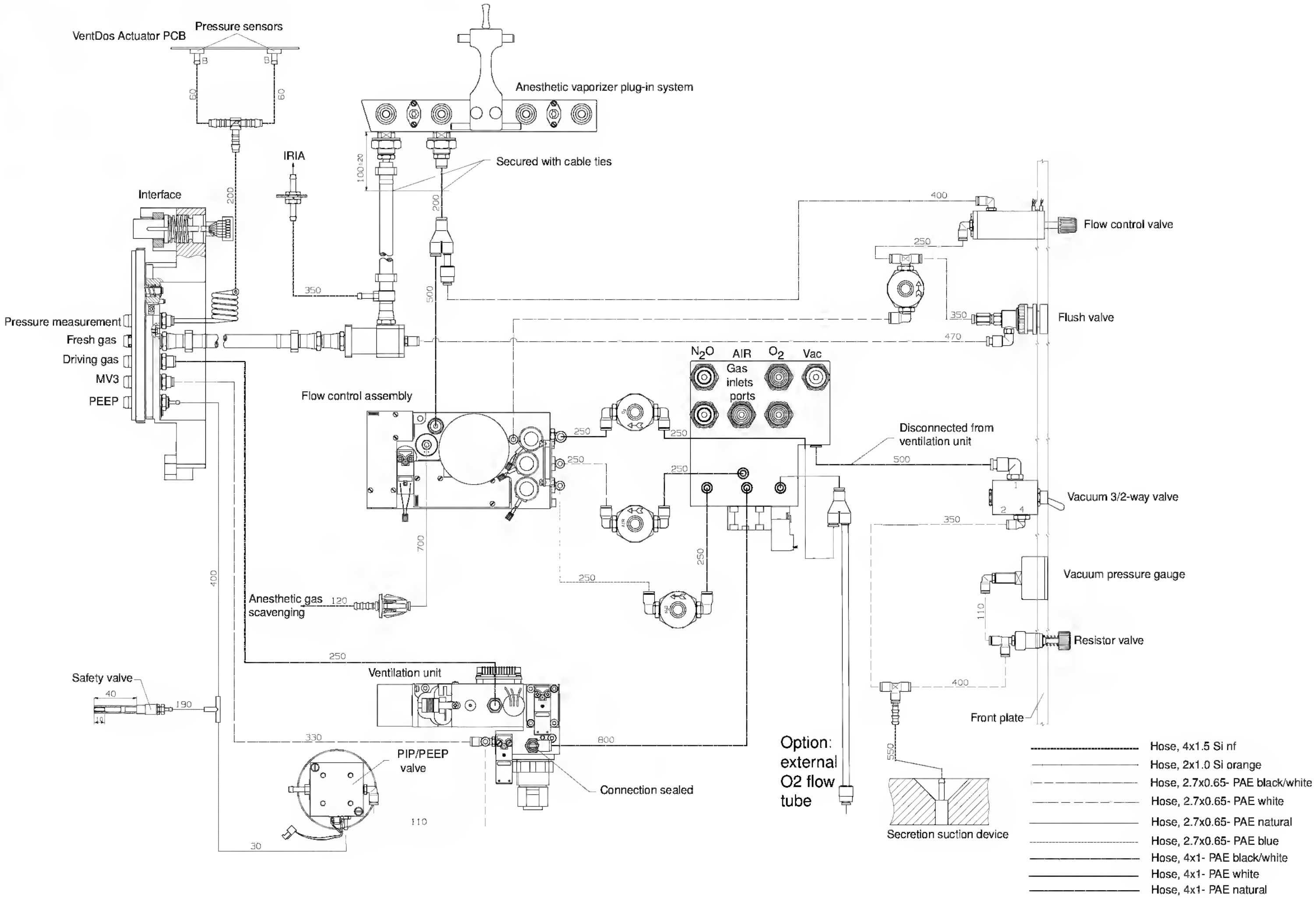


Fig.126: Tubing diagram (US version)

59.1 Tubing diagram of Julian with A-cone, USA version as of 09/2000

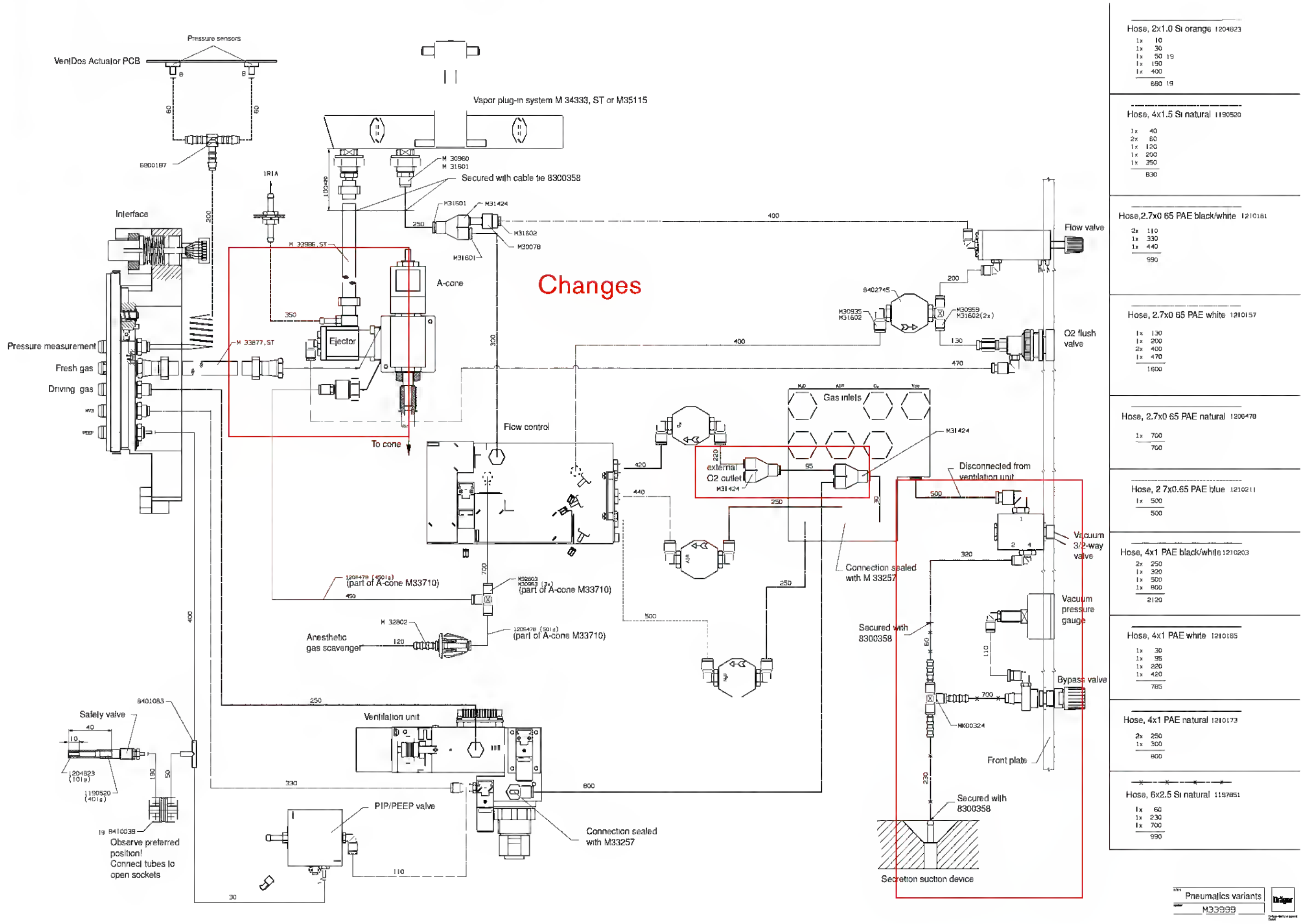


Fig.127: Tubing diagram of Julian with A-cone, USA version as of 09/2000

59.2 Tubing diagram of Julian with Vac suction, USA version as from 09/2000

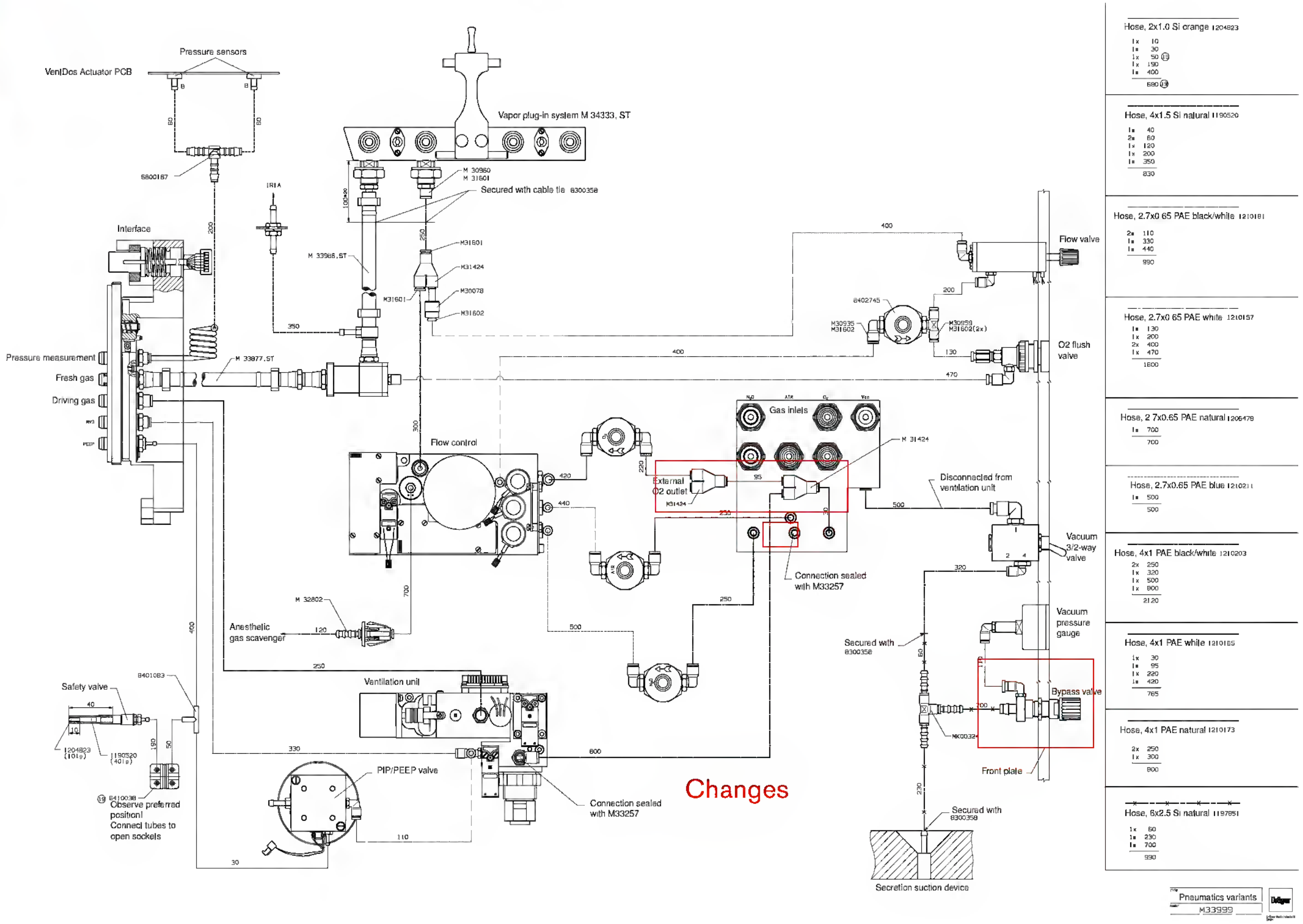


Fig. 128: Tubing diagram of Julian with Vac suction, USA version as of 09/2000

Function Description

Pneumatics

Contents:

60 Actuator PCB

The Actuator PCB contains the following function groups:

- analog circuit for valve control,
- stepper motor control,
- pressure-sensor connection(s),
- Ventdos Controller PCB /motherboard interface.

The Ventdos Controller PCB uses the Actuator PCB to actuate the valves and read the pressure sensors. The Actuator PCB is part of the analog circuit. It provides some of the valve status signals which are processed by the Ventdos Controller PCB.

The Actuator PCB provides the interface for the Ventdos Controller PCB. All Ventdos Controller PCB connections to peripheral components are made via the Actuator PCB.

60.1 A-Cone and Safety Valve Control

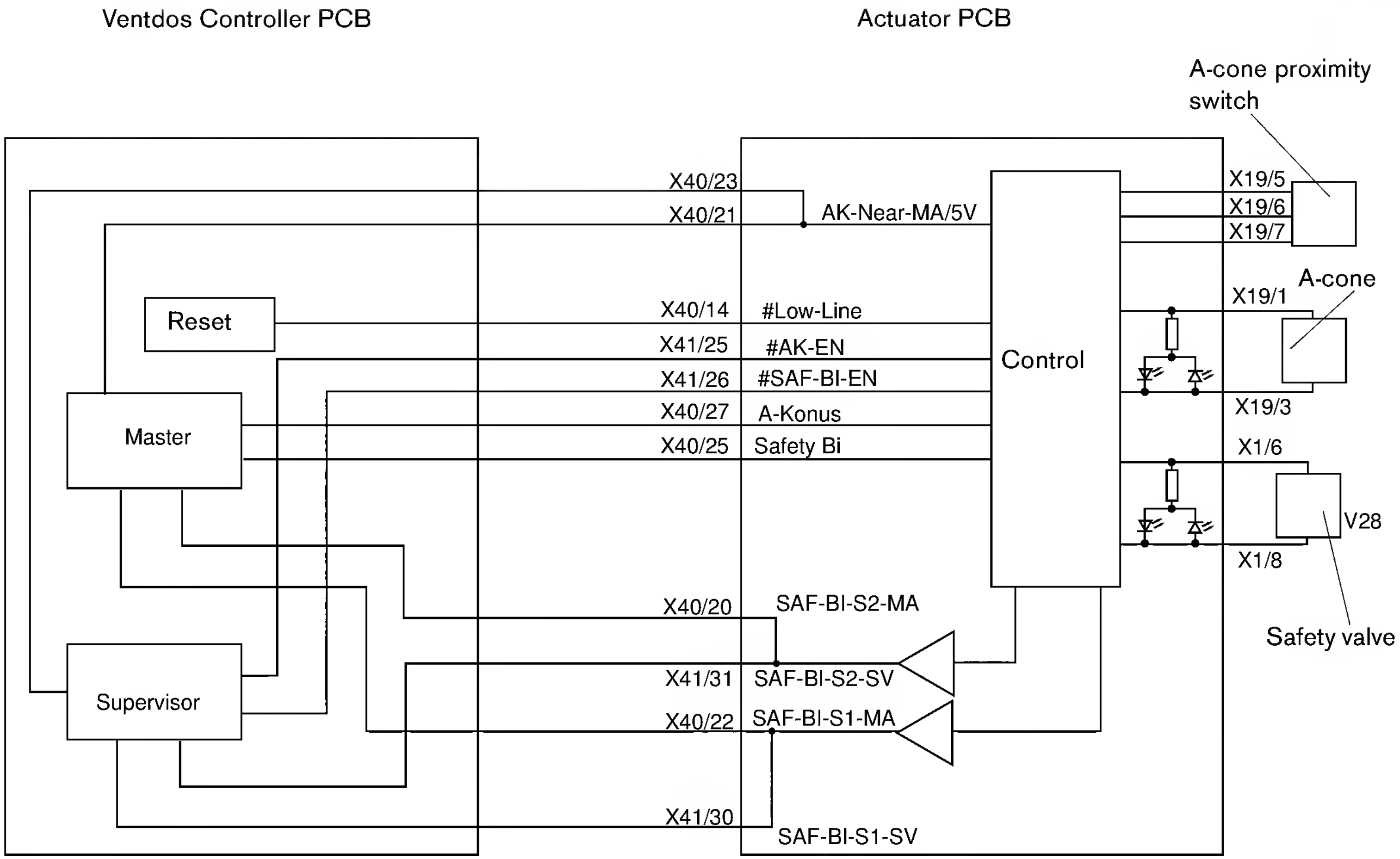


Fig.129: Block diagram of the A-cone and the safety valve control

60.2 PEEP Valve Control

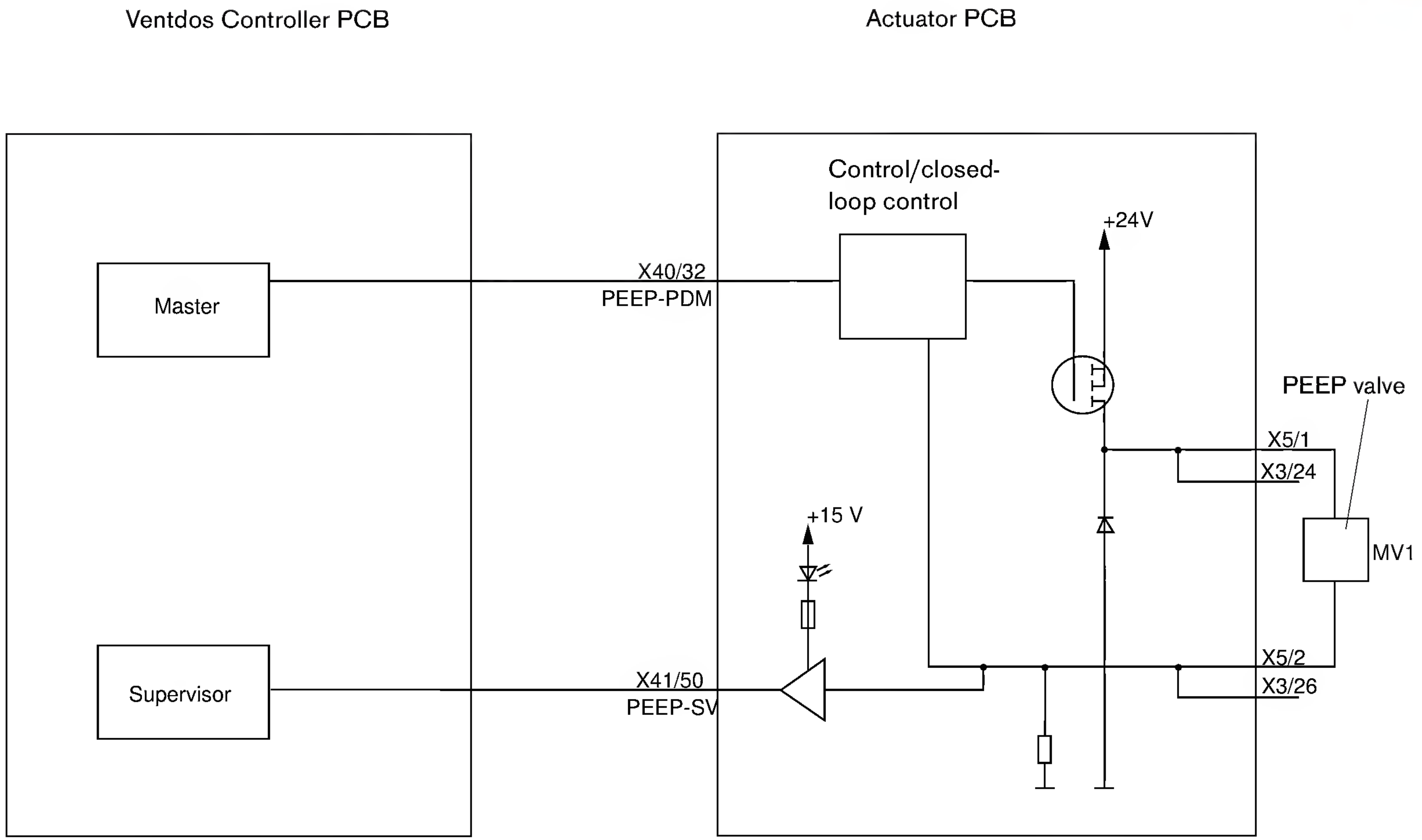


Fig. 130: PEEP valve control block diagram

60.3 Proportional Valve Control and System Pressure

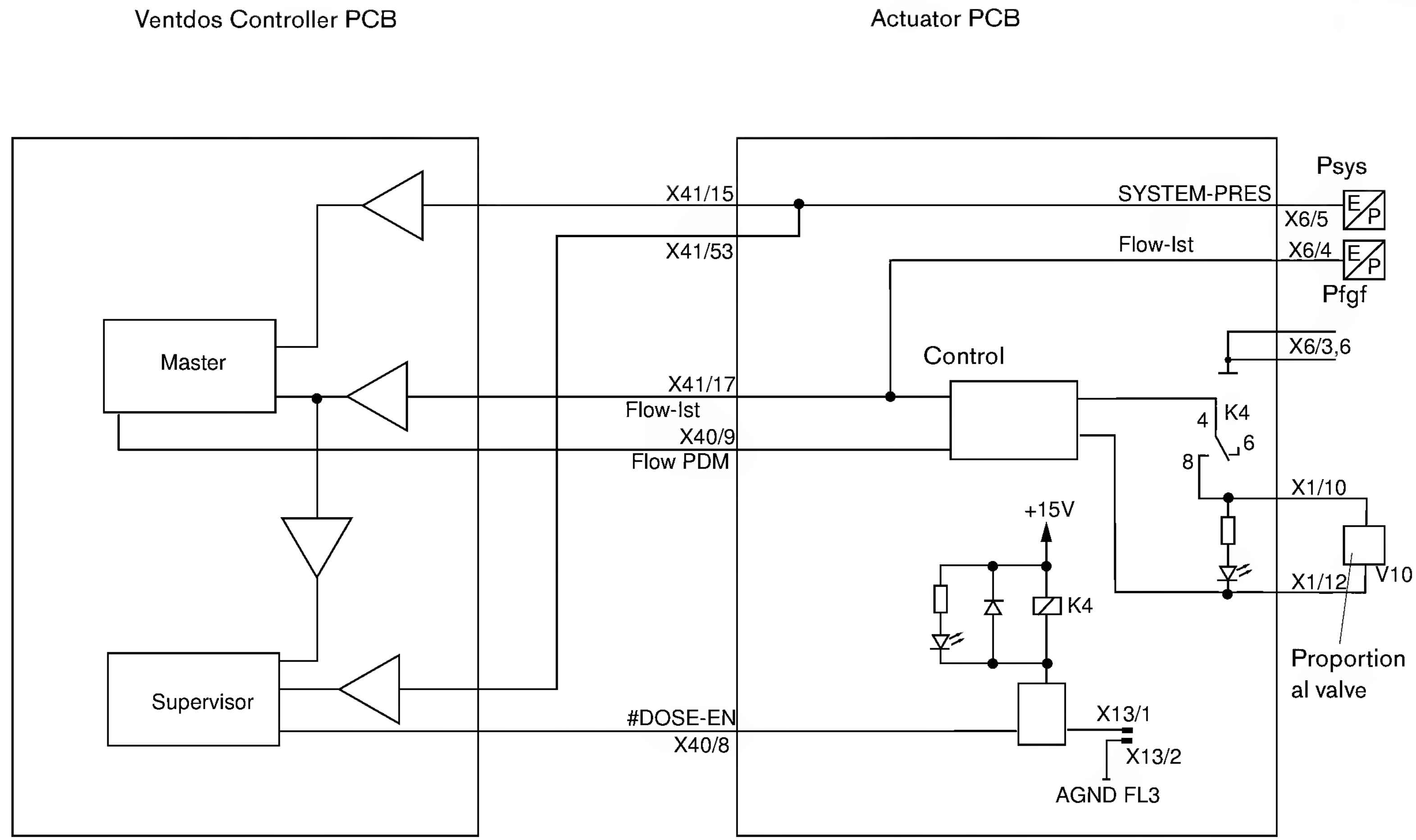


Fig.131: Proportional valve control and system pressure block diagram

60.4 Pressure Sensors Paw, Phigh and P_{AIR}

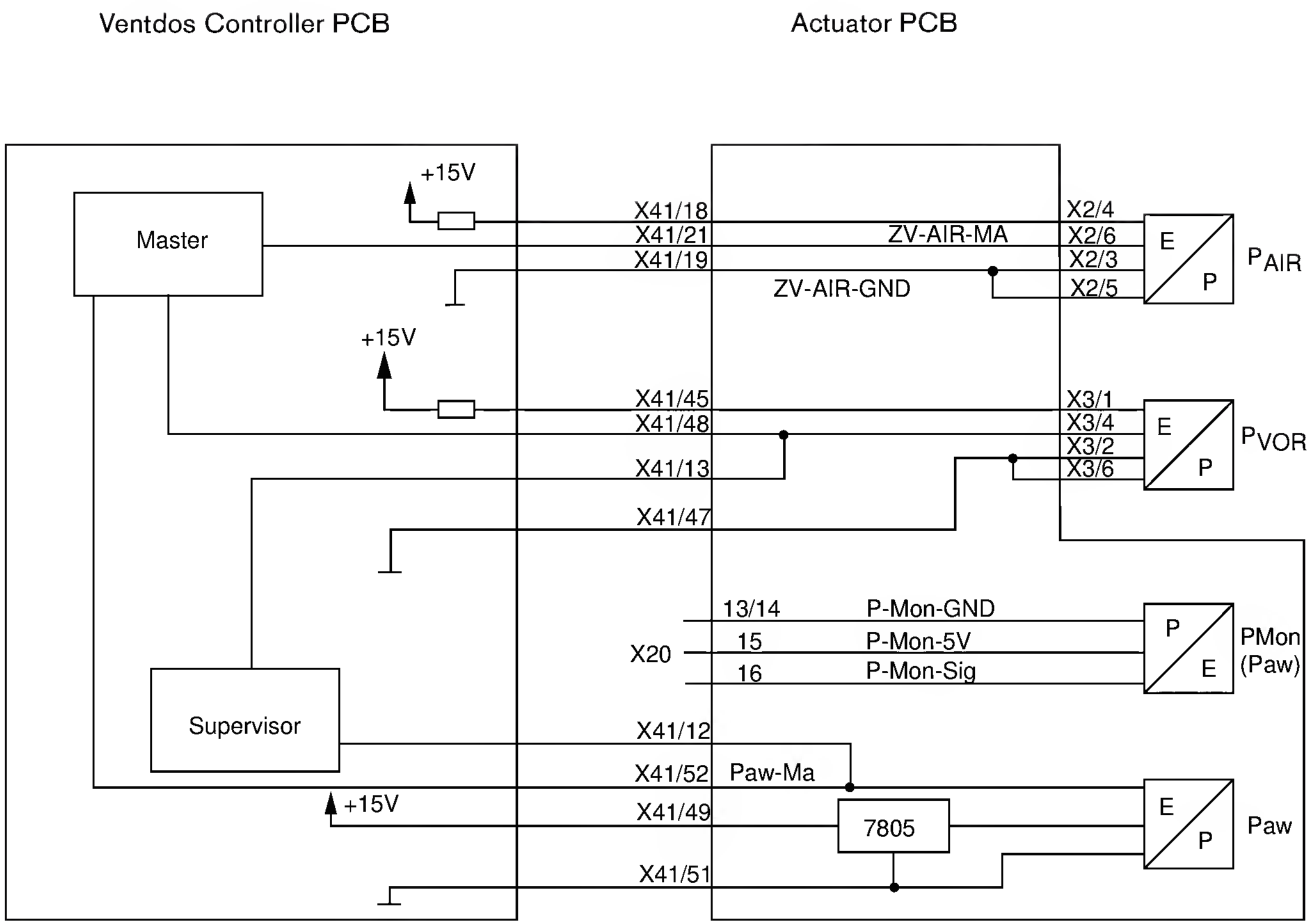


Fig.132: Block diagram of pressure sensors

60.5 Slot Valve Control

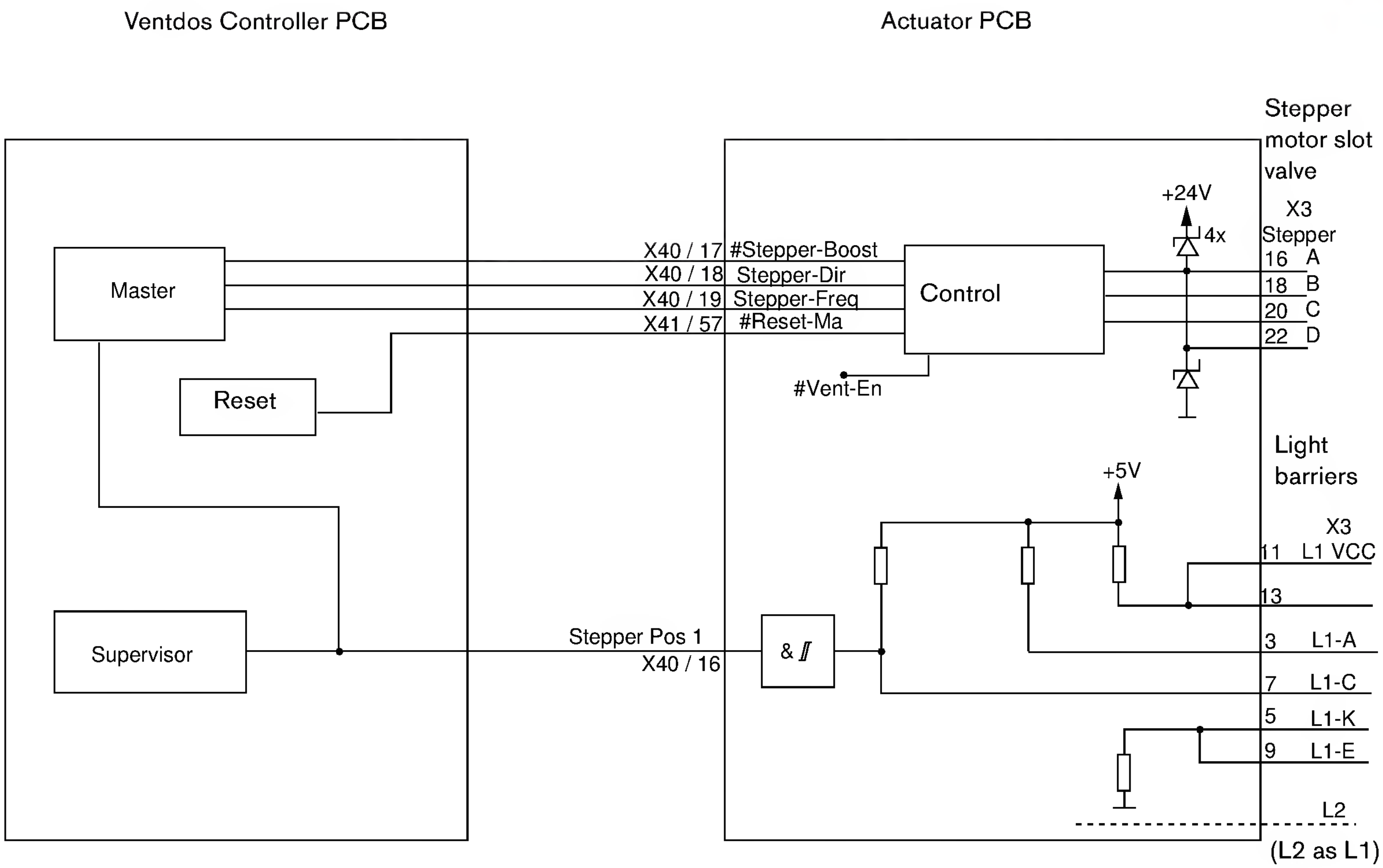


Fig.133: Slot valve control block diagram

60.6 Valve Control for MV3, MV2, N_2O, AIR, O_2, Safety and V7

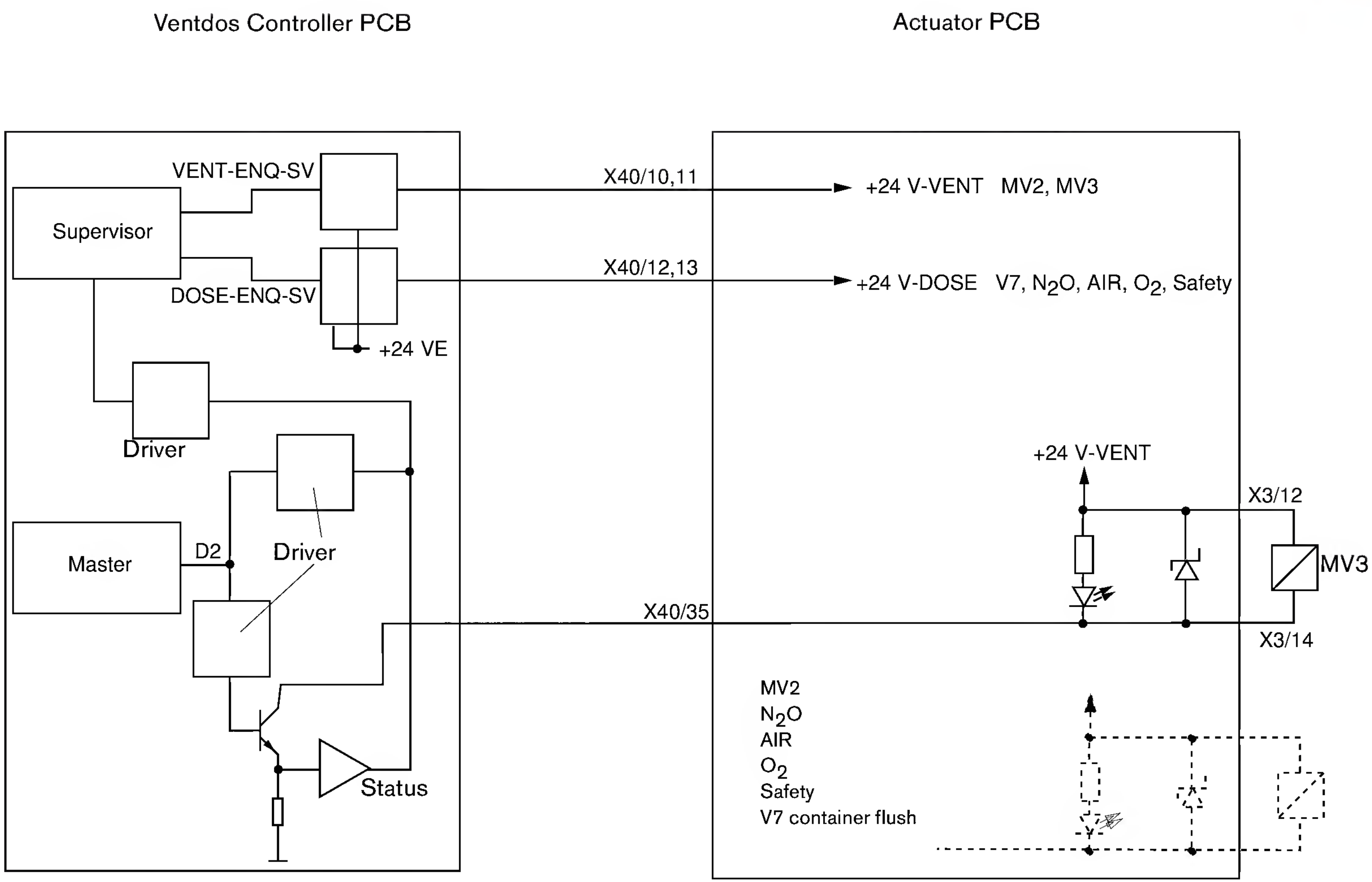


Fig. 134: Valve control block diagram

60.7 Heater control

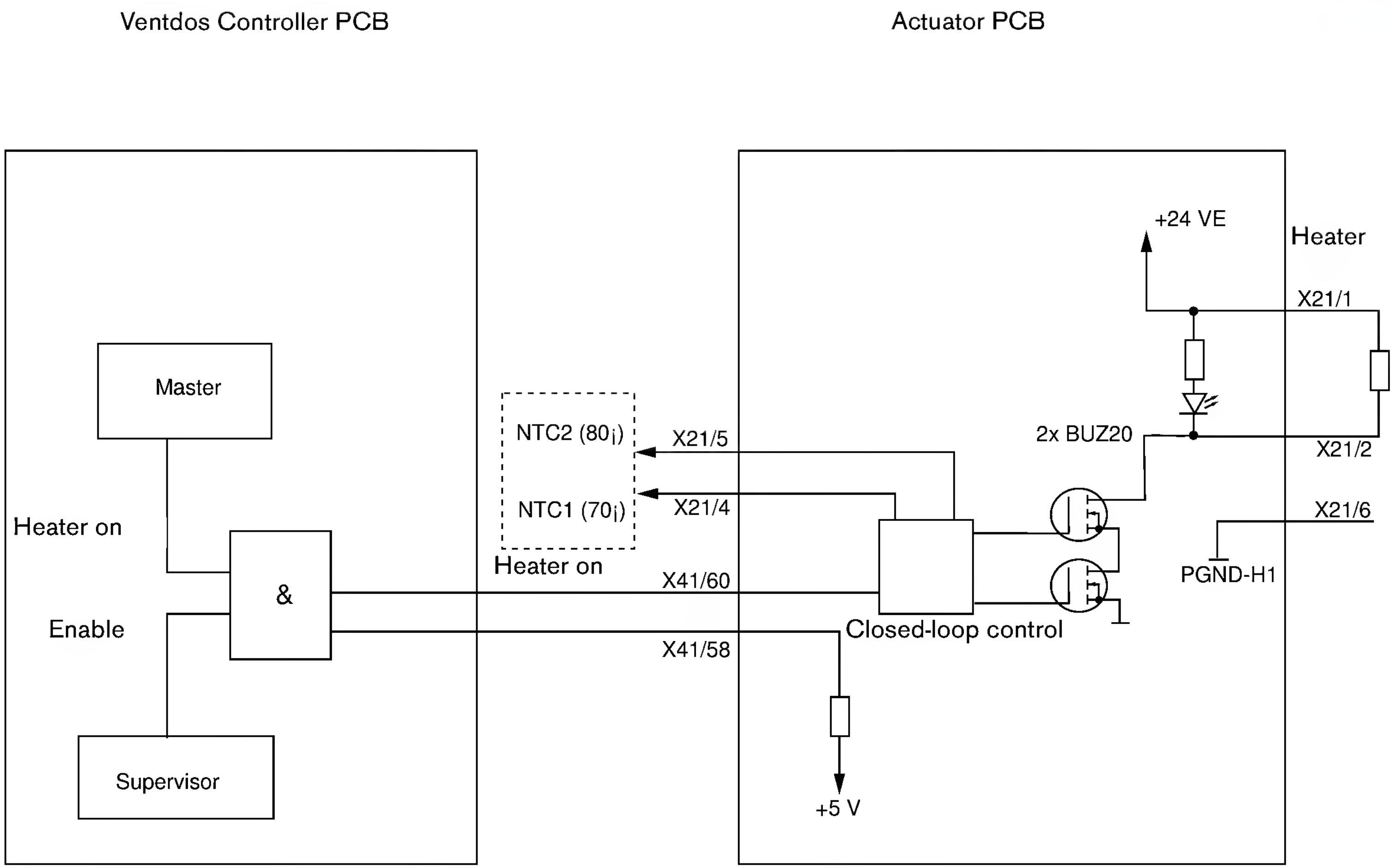


Fig.135: Block diagram of heater control

60.8 Fan control

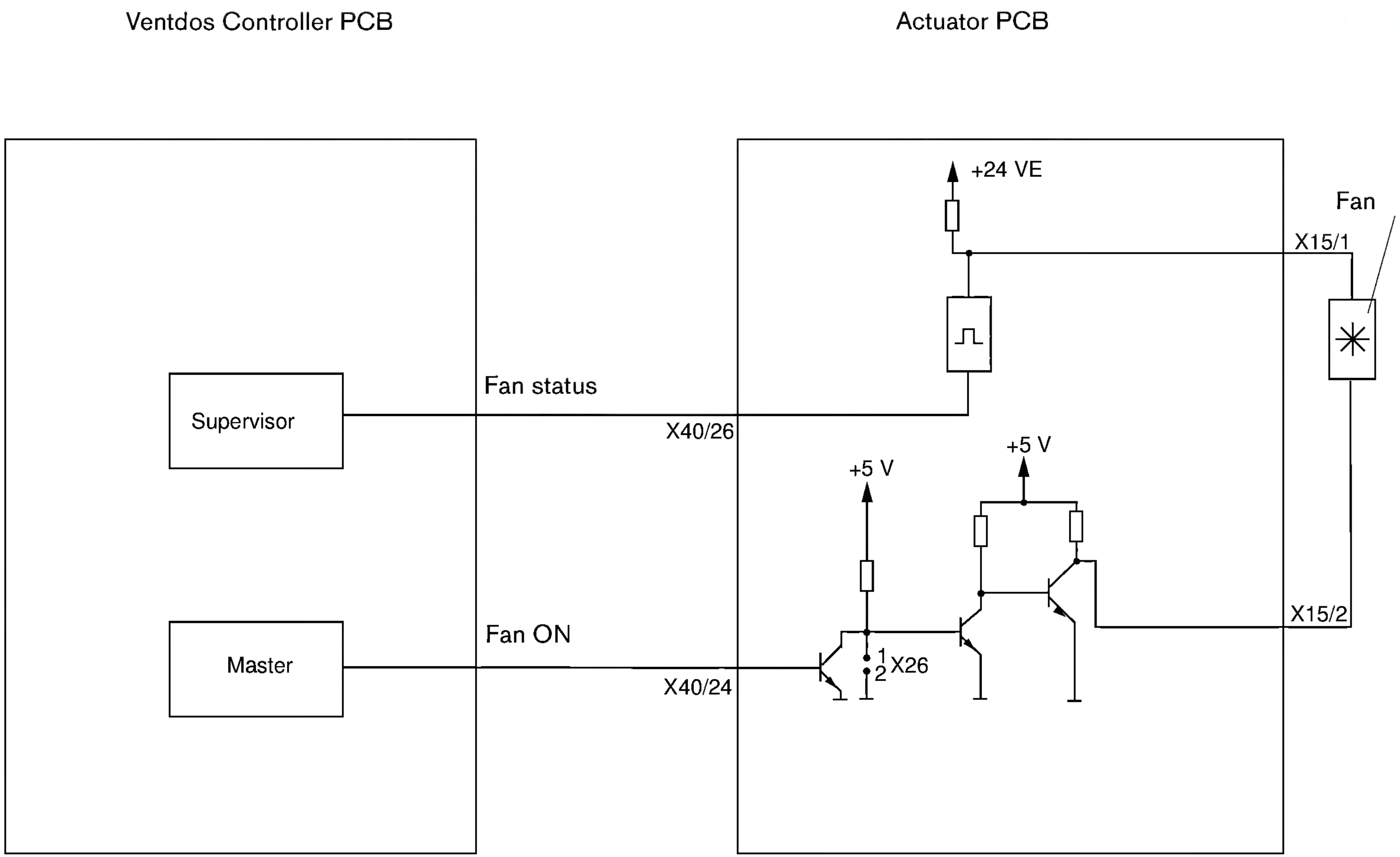


Fig.136: Block diagram of fan control

60.9 Mixer Flow and Container Pressure

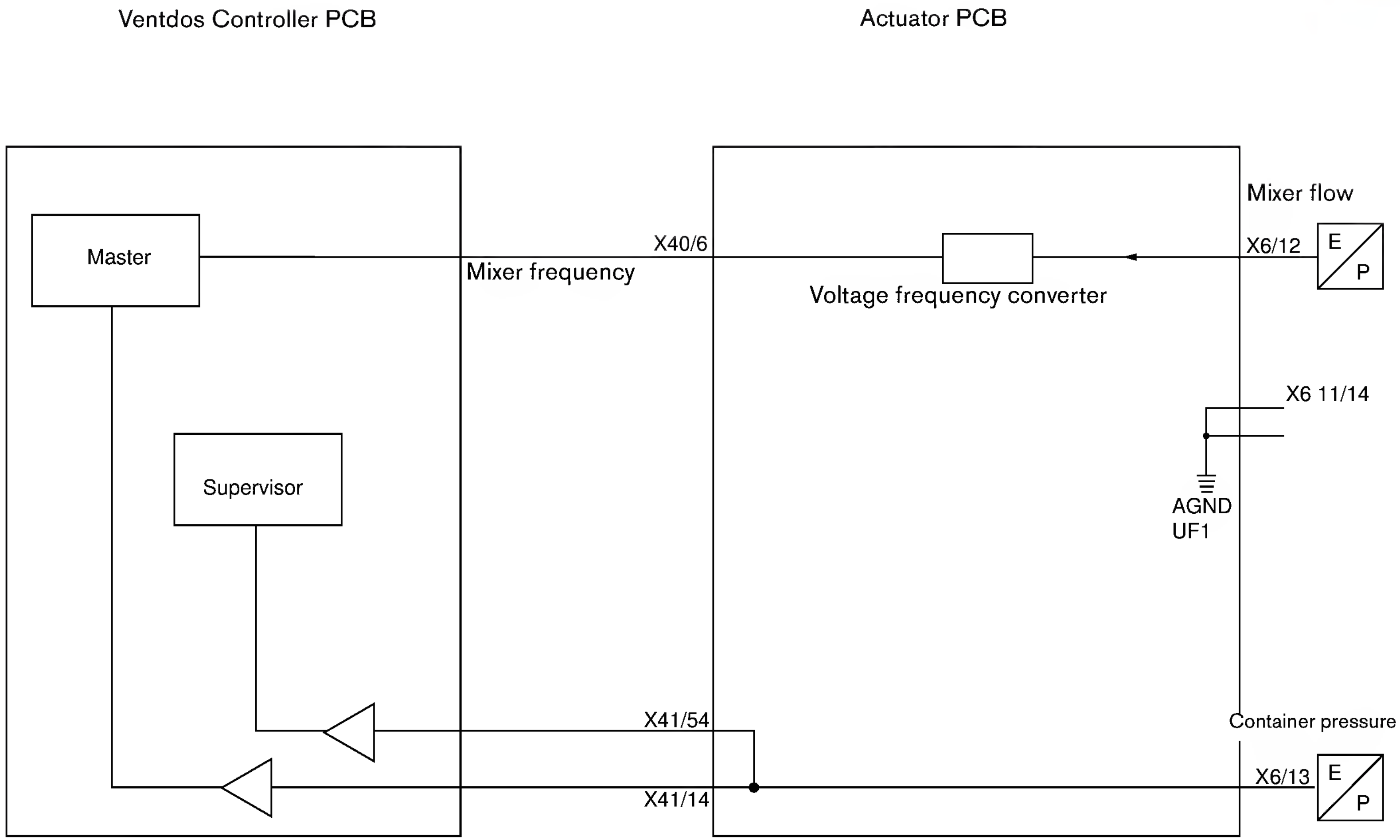


Fig.137: Block diagram of mixer flow and container pressure

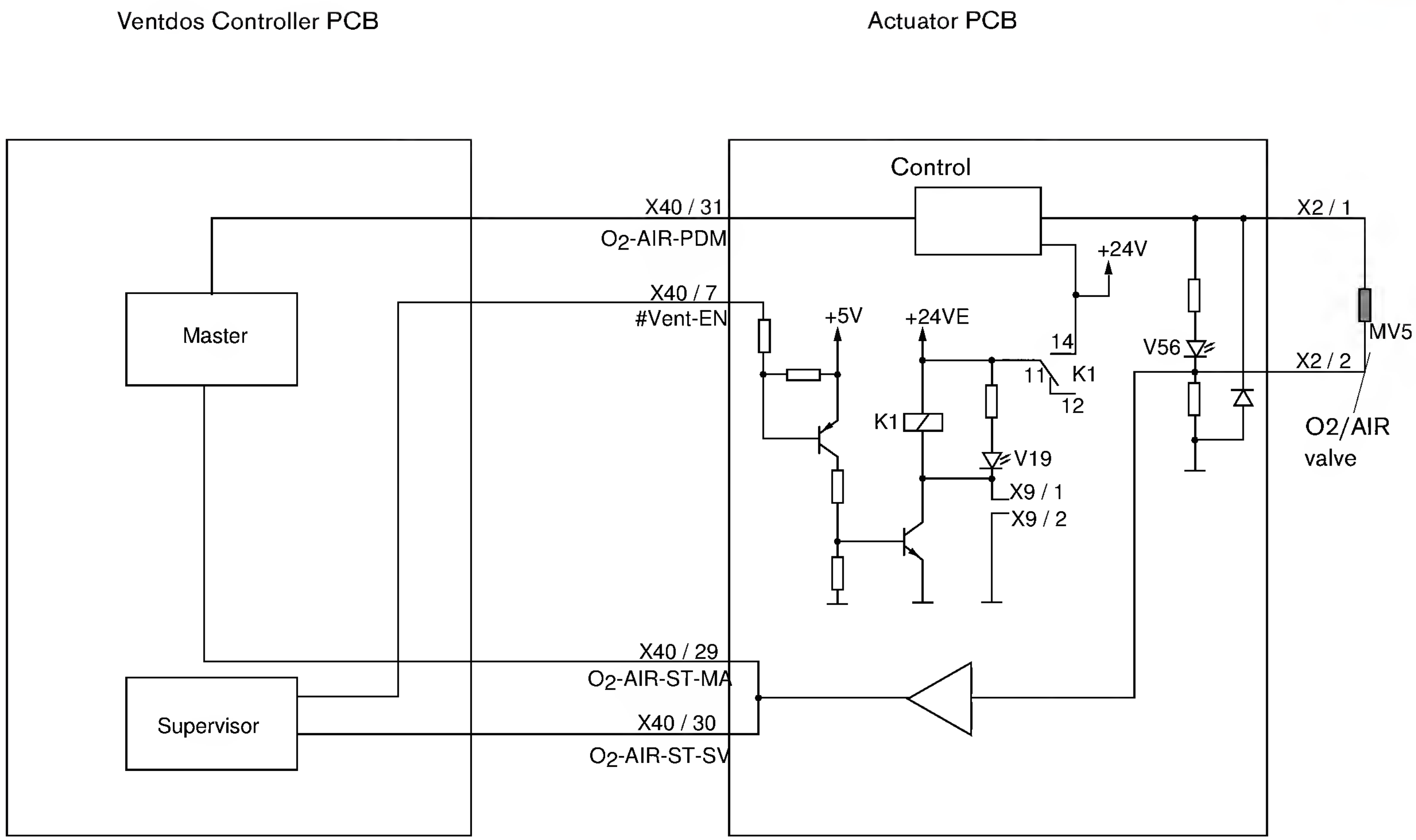


Fig.138: Block diagram of O_2/AIR valve control

61 Ventdos Controller PCB

see Pneumatics on page 418

62 Gas inlet block

62.1 Standard version of the gas inlet block

Julian is connected to the pipeline system via three ISO connections which are located on the rear panel. Pipeline pressures for O_2, N_2O, and AIR range from 2.7 bar to 5.5 bar. These pressures are indicated by pressure gauges on the front panel.

An optional high-pressure conversion kit can be connected via two additional ISO connections. This high-pressure conversion kit consists of two gas cylinders (O_2 and N_2O). The high pressure regulators (200 bar/5 bar for O_2 and 60 bar/5 bar for N_2O) and the check valves are located on the gas cylinders. The gas cylinder pressure is indicated on the pressure gauge of the respective pressure regulator.

In the US version of the pneumatics, the three pressure regulators are located in the supply lines of the pipeline valves. These pressure regulators keep the pressure for the pipeline valves at a constant level (approx. 3.5 bar).

62.2 Driving gas switchover

The MV5 valve is actuated during operation thereby selecting AIR to drive the ventilator and the bronchial suction device. The P_{AIR} differential pressure sensor monitors the AIR supply pressure. If the AIR supply pressure decreases below 2.3 bar, the Ventdos Controller PCB switches the MV5 valve to O_2. The Julian continues operating with O_2. As soon as AIR is available again, the Ventdos Controller PCB switches the MV5 valve back to AIR.

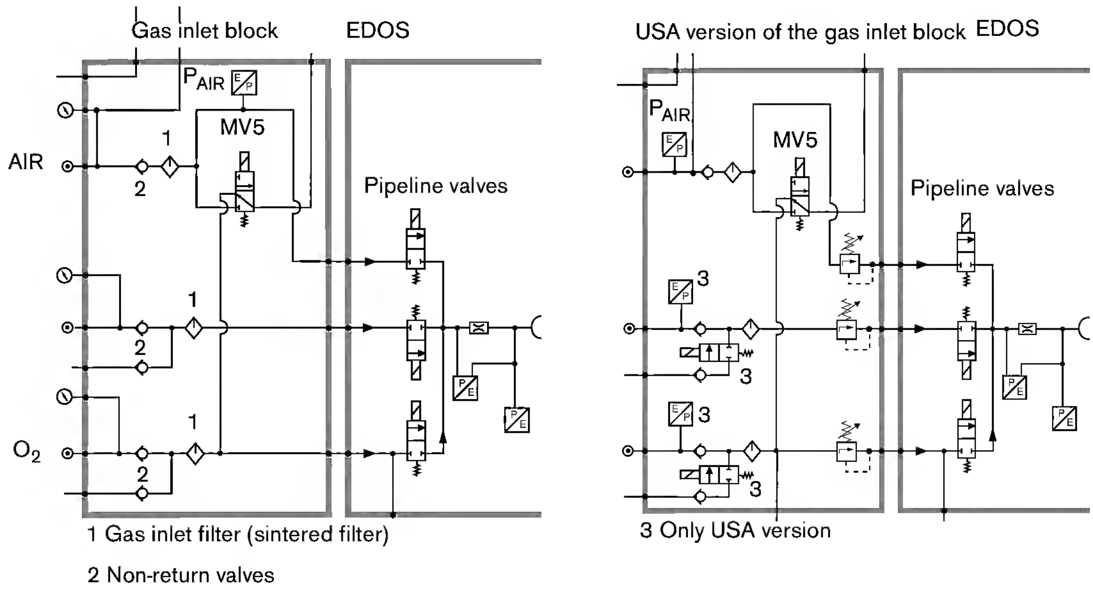


Fig.139: Driving gas switchover

62.3 USA version of the gas inlet block

Julian is connected to the pipeline system via three ISO connections which are located on the rear panel. Pipeline pressures for O_2, N_2O, and AIR range from 2.7 bar to 5.5 bar. These pressures are digitally displayed on the front panel.

An optional high-pressure conversion kit can be connected via two additional ISO connections. This kit consists of two gas cylinders (O2 and N2O). The high pressure regulators (200 bar/5 bar for O2 and 60 bar/5 bar for N2O) and the check valves are located on the gas cylinders. The gas cylinder pressure is displayed on digital displays. The digital displays are located on the front of the unit. Cylinder pressure sensors are located on the respective pressure regulators.

If, for example, the O_2 pipeline fails, Julian switches to O_2 gas cylinder supply (if available) by means of electrical reversing valves.

62.3.1 Digital display control

The printed circuit board assemblies EPI Controller PCB and EPI Display PCB control the digital displays and evaluate the pressure signals.

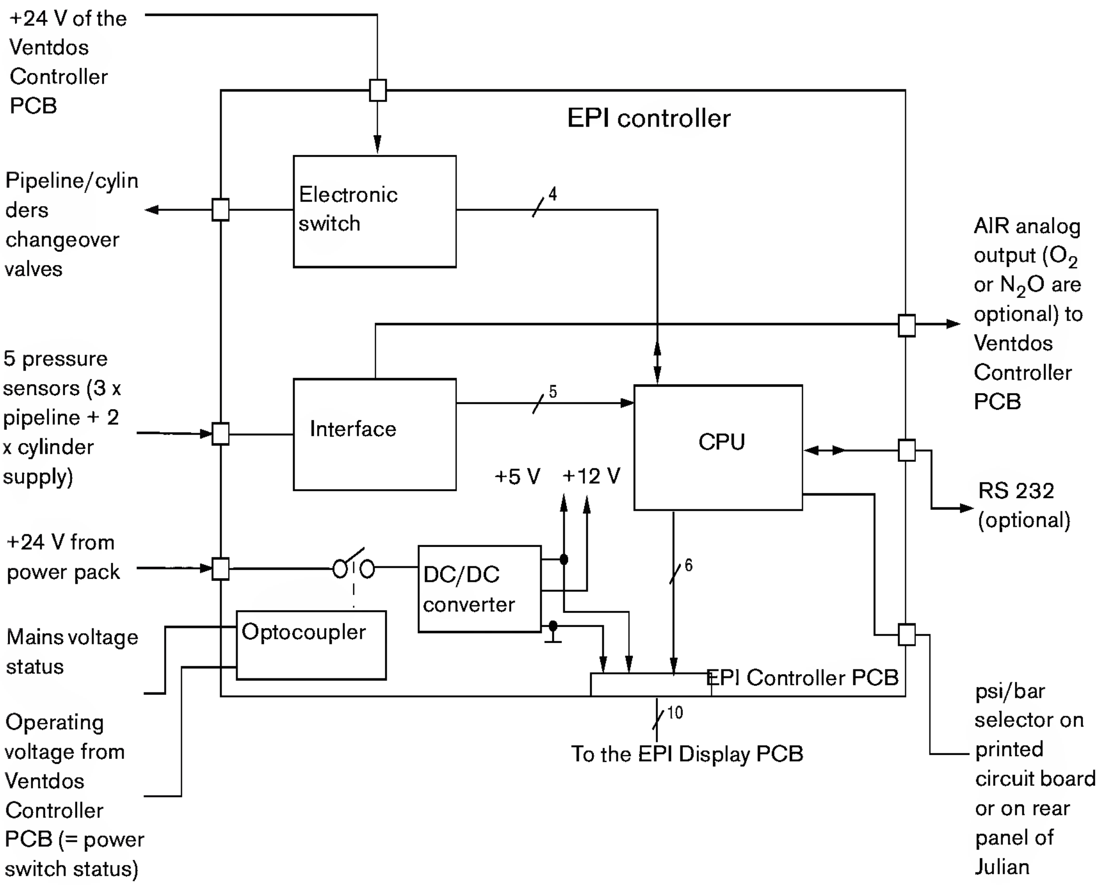


Fig.140: Display and evaluation of pipeline and cylinder pressure

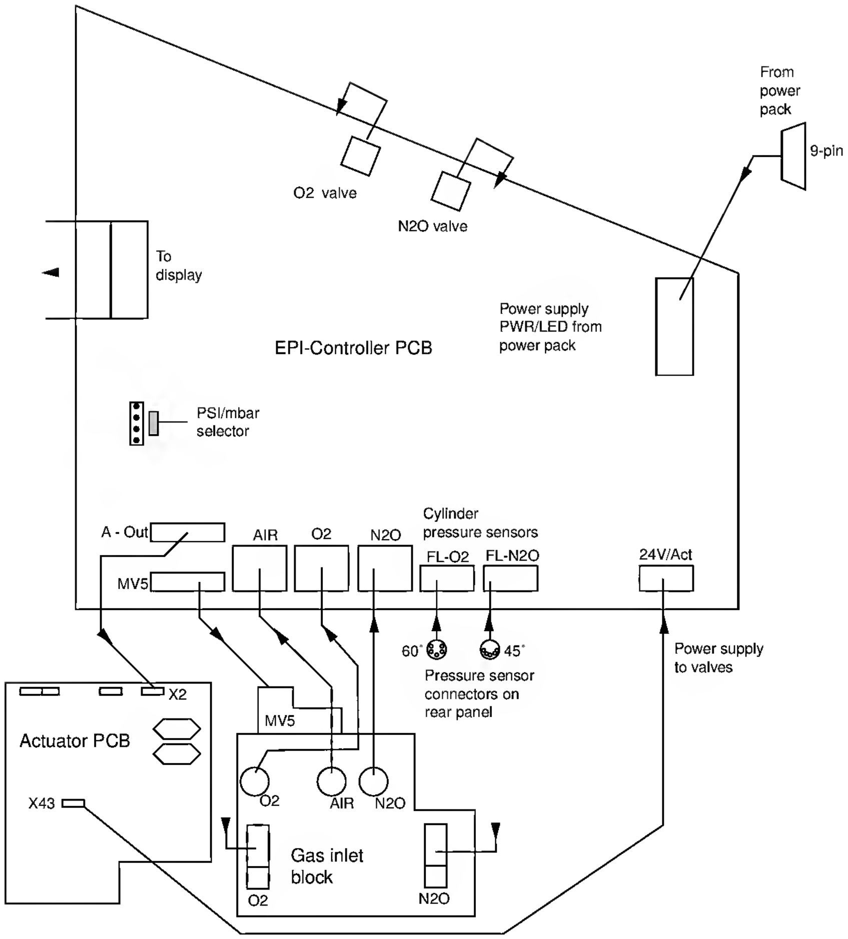
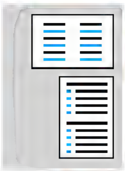


Fig. 141: Interconnection diagram of EPI controller, actuators and gas inlet block



Function

The digital displays located on the front panel indicate the pipeline system and gas cylinder pressures. The display range for pipeline system pressures lies between 0 and 9.9 bar (tolerance for the range 2.7 to 5.5 bar is ±2%), the display range for gas cylinder pressures lies between 0 and 190 bar (±4%). A mechanical selector on the rear panel allows the user to switch the pressure unit display from bar to psi. The CPU on the EPI-Controller PCB verifies the position of the switch and processes the pressure signals accordingly.

Pressure values are displayed under the following conditions:

- Julian is turned ON (powered either from AC supply or backup battery)
- Julian is turned OFF, but the power cord is connected to the AC outlet (the CPU on the EPI-Controller PCB recognizes this status via the "Mains Voltage" status line)

Built-in pressure sensors measure the pressure (pipeline system = O_2, AIR, N_2O; gas cylinders = O_2, N_2O). The pressure signals are processed by the EPI-Controller PCB. If the pipeline system pressure decreases below one of the set lower limits, the CPU switches the respective solenoid valve to the gas cylinder supply position and generates an alarm.

The CPU controls the digital display which indicate the pressure values either in bar or psi. The measured values are available as analog or digital (RS232) signals through external interfaces. The digital interface is not used in Julian. The analog voltages are fed to the Ventdos Controller PCB.

Monitoring

The CPU located on the EPI-Controller PCB monitors the pipeline system and gas cylinder pressures. If a pressure decreases below a specified value, the digital displays start to flash and an audible alarm sounds for 60 s. This alarm is generated under the following conditions:

O2, N2O:

- If, after the last power-on, the pipeline system pressure has decreased below 2.7 bar and there is no gas cylinder pressure available (for example, gas cylinders are closed), or if the gas cylinder pressure is below 10 bar and the pipeline system pressure is below 2.7 bar.

AIR:

- If pipeline system pressure decreases below 2.7 bar.

The alarm will be deactivated as soon as the pressure is within specified limits or when Julian is switched off.

Representation

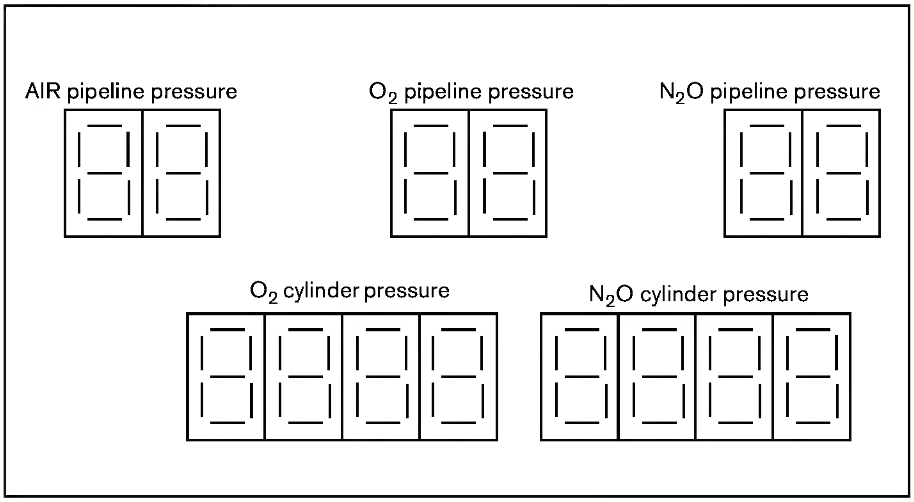


Fig.142: Digital displays on the EPI Display PCB

62.3.2 Driving gas switchover

The MV5 valve is actuated during operation thereby selecting AIR to drive the ventilator and the bronchial suction device. The pressure sensor in the AIR pipeline inlet monitors the AIR supply pressure. If the AIR supply pressure decreases below 2.3 bar, the Ventdos Controller PCB switches the MV5 valve to O_2. The Julian continues operating with O_2. As soon as AIR is available again, the Ventdos Controller PCB switches the MV5 valve back to AIR.

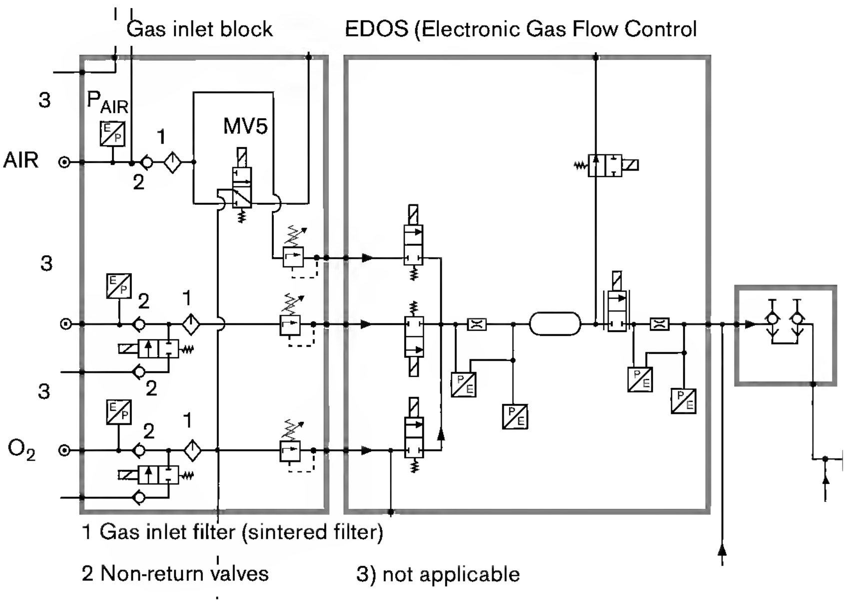


Fig.143: Driving gas switchover (US version of pneumatics)

63 EDOS (Electronic Gas Flow Control Device)

63.1 General

EDOS is an electronic device which controls and mixes the gases (O_2+N_2O or O_2+AIR). Depending on the set mix ratio (N_2O/O_2 or AIR/O_2), the Ventdos Controller PCB actuates the pipeline system valves (ZV2/ZV3 or ZV1/ZV3) subsequently via the Actuator PCB.

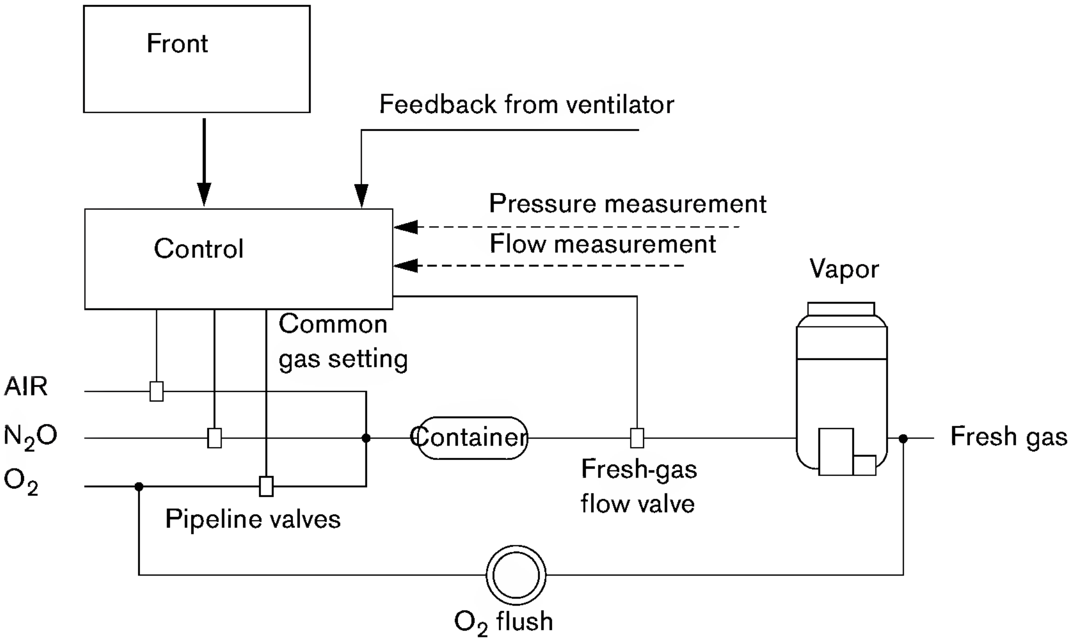


Fig.144: Schematic diagram of the electronic gas flow control device

63.2 Working principle

The pipeline system valves open when the pressure in the container decreases to 0.6 bar. At a fresh-gas flow setting of 12 L/min, the pipeline system valves (ZV2/ZV3 or ZV1/ZV3) are actuated forty times per minute, that is, the container is filled forty times per minute ($40\ min^{-1}$ x 0.3 L = 12 L/min). The working pressure in the container ranges from 0.6 bar to 1.2 bar. The pressure difference in a container of ΔP_{tank} = 0.6 bar and a volume of 0.5 L result in a usable container volume of 0.3 L (0.6 bar x 0.5 L = 0.3 L).

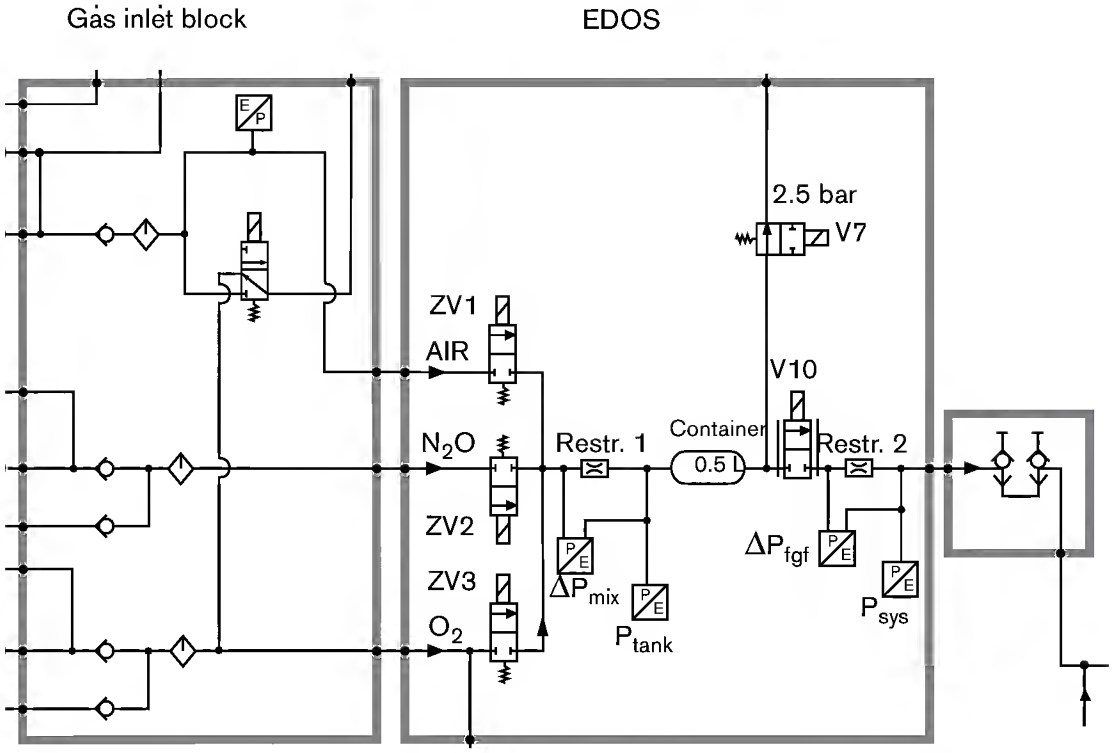


Fig.145: EDOS

The flow and the volume of the inlet gas (flow x time = volume) is measured with a pressure sensor ΔP_{mix} and a restrictor (restr.1). If a constant usable container volume of 0.3 L is used then any given gas concentration can be mixed.

Pressure sensor ΔP_{mix} and pressure sensor ΔP_{fgf} measure the mass flow (these pressure sensors are sensitive to fluctuations in atmospheric pressure). Fluctuations are compensated by the absolute pressure sensors P_{tank} and P_{sys}.

The pressure sensor P_{tank} performs several tasks:

- It monitors the container pressure.
- It measures the atmospheric pressure and compensates for effects of atmospheric pressure fluctuations on the flow measurement ΔP_{mix}.
- It monitors the flow measurement path (2 channels) using the proportional pressure increase in the container.

The pressure sensor ΔP_{fgf} measures the flow at the restrictor (restr. 2). The Ventdos Controller PCB uses the measured value to control the fresh-gas flow valve (V10, see also chapter "Fresh-gas flow control" on page 439). The pressure sensor P_{sys} controls the pressure in the breathing system and compensates for effects of atmospheric pressure on the flow measurement of ΔP_{fgf}.

Safety valve V7 opens under the following conditions:

- No O_2 and AIR available.
- The container pressure exceeds 2.5 bar.

63.2.1 Fresh-gas flow control

During expiration, the fresh-gas flow valve (V10) delivers the set fresh-gas flow. Since the fresh-gas flow valve can only deliver a maximum rate of 12 L/min, in some device configurations fresh-gas is also delivered during the inspiratory phase. At a T_I:T_E ratio of 1:1 and a fresh-gas flow rate > 6 L/min (12 L/min in 30 s = 6 L/min), the fresh-gas flow valve, e.g., also opens during inspiration. The fresh-gas decoupling function is not affected (see also the two examples below). The tidal volume VT is reduced accordingly.

Example 1:
Fresh gas = 4 L/min
T_I:T_E = 1:1
Freq. = 10
V_T = 600 mL
V_{TC} = additional volume applied for compliance correction purposes
T_{IP}:T_I= 0

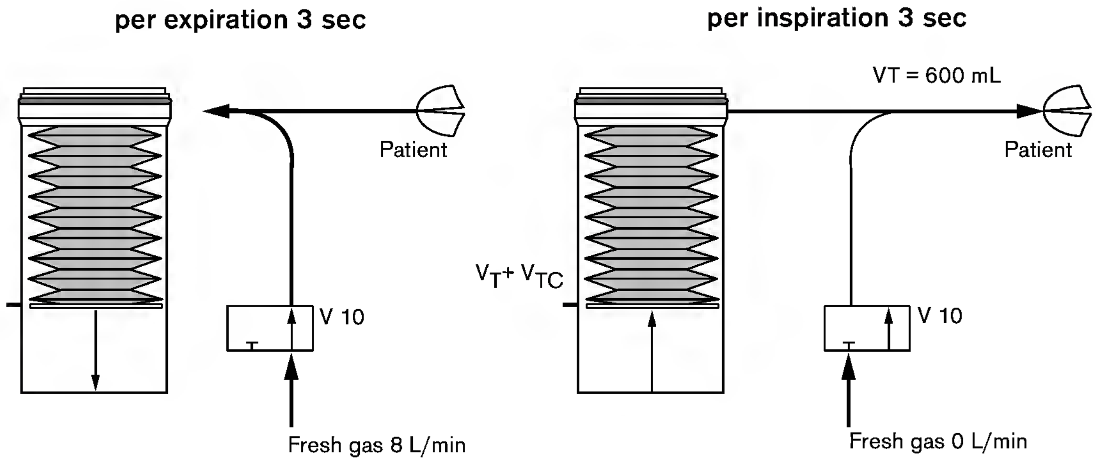


Fig.146: Bellows movement at 4 L/min fresh gas

Example 2:
Fresh gas = 8 L/min
T_I:T_E = 1:1
Freq. = 10
V_T = 600 mL
T_{IP}:T_I= 0

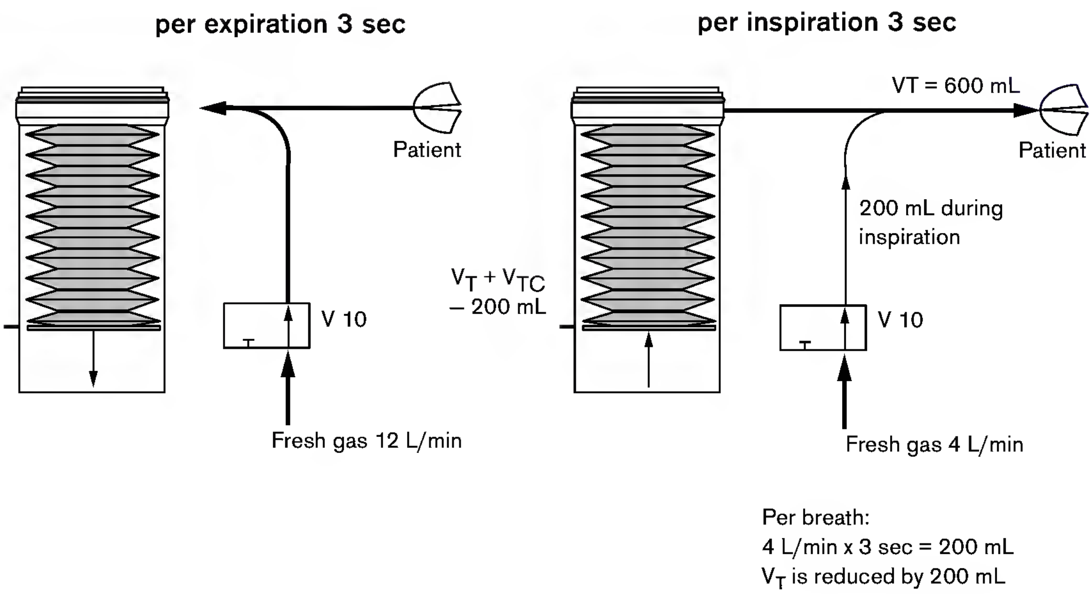


Fig.147: Bellows movement at 8 L/min fresh gas

64 O_2 flush and emergency flow control (safety flow)

64.1 O_2 flush

O_2 flush is connected directly to the O_2 supply and to the fresh-gas inlet. O_2 flush functions as a bypass. After pressing the O_2 button, O_2 flows into the breathing system. It is delivered directly to the patient.

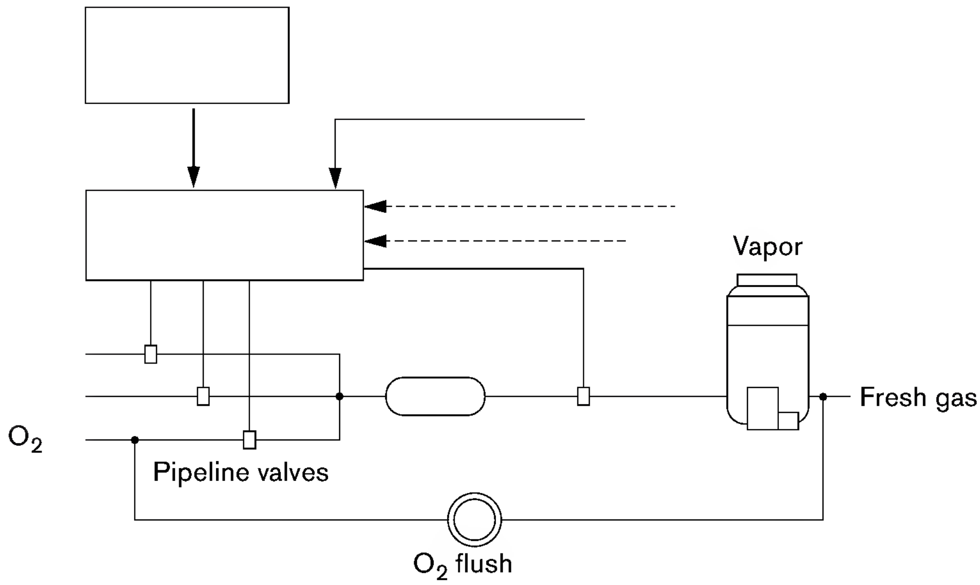


Fig. 148: O_2 flush

64.2 Emergency flow control (safety flow)

Emergency flow control is a safety feature which ensures that the patient can be ventilated manually in the event of power failure.

64.2.1 Emergency flow control

If Julian is switched off and its pneumatics is deactivated, valve V27 is open and bistable valve V28 is closed. If Julian is switched on, valve V27 is closed and bistable valve V28 is open. If power supply (from AC outlet and uninterruptible power supply) fails, valve V27 opens. Bistable valve V28 remains open. This ensures a O_2 fresh-gas supply of 4 to 8 L/min to the patient.

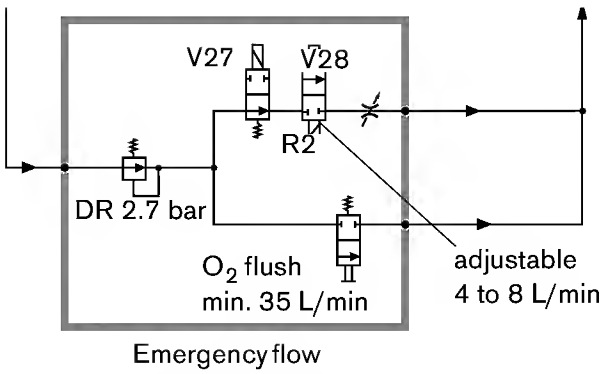


Fig.149: Emergency flow valves

64.2.2 US version of emergency flow control (pneumatics)

The US version has an adjustable flow control with ON/OFF identification instead of the V27 and V28 valves. The user can adjust the emergency flow control from 0 to 12 L/min. If emergency flow control has been activated, the Ventdos Controller PCB shows a corresponding message on the display. Since 1999, the emergency flow control with flow control valve has also been implemented in the standard pneumatics.

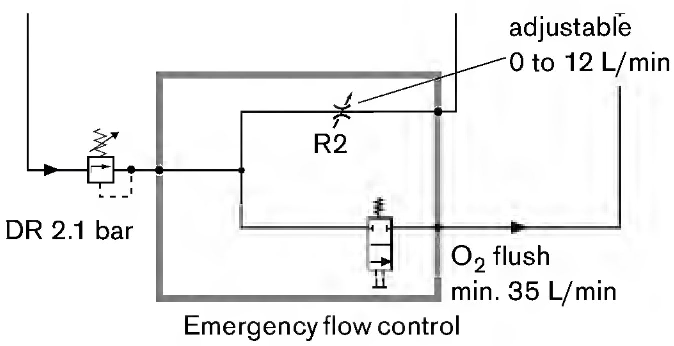


Fig.150: US version of the emergency flow control

65 Secretion suctioning (optional)

Two different secretion suction devices are available for secretion suctioning:

- secretion suctioning via ejector with AIR/O2 (see 65.1)
- secretion suctioning via ejector with AIR (see 65.2)
- Secretion suctioning via VAC connection

65.1 Secretion suctioning via ejector with AIR/O2 (until 09/2000)

The secretion suctioning is identifiable by the typeplate (Pressure: 3.5 or 5 bar). The control and display elements of the secretion suction device are located on the control panel. The secretion suction device (including a secretion trap bottle and a flush bottle) is installed in a mount on one side of the trolley. Vacuum for the secretion suction device is generated by an ejector. During normal operation, the secretion suction device is operated from an adjustable compressed-air ejector which can be switched to O_2 operation should the AIR supply fail. A pressure relief valve limits the suction pressure in the secretion suction line.

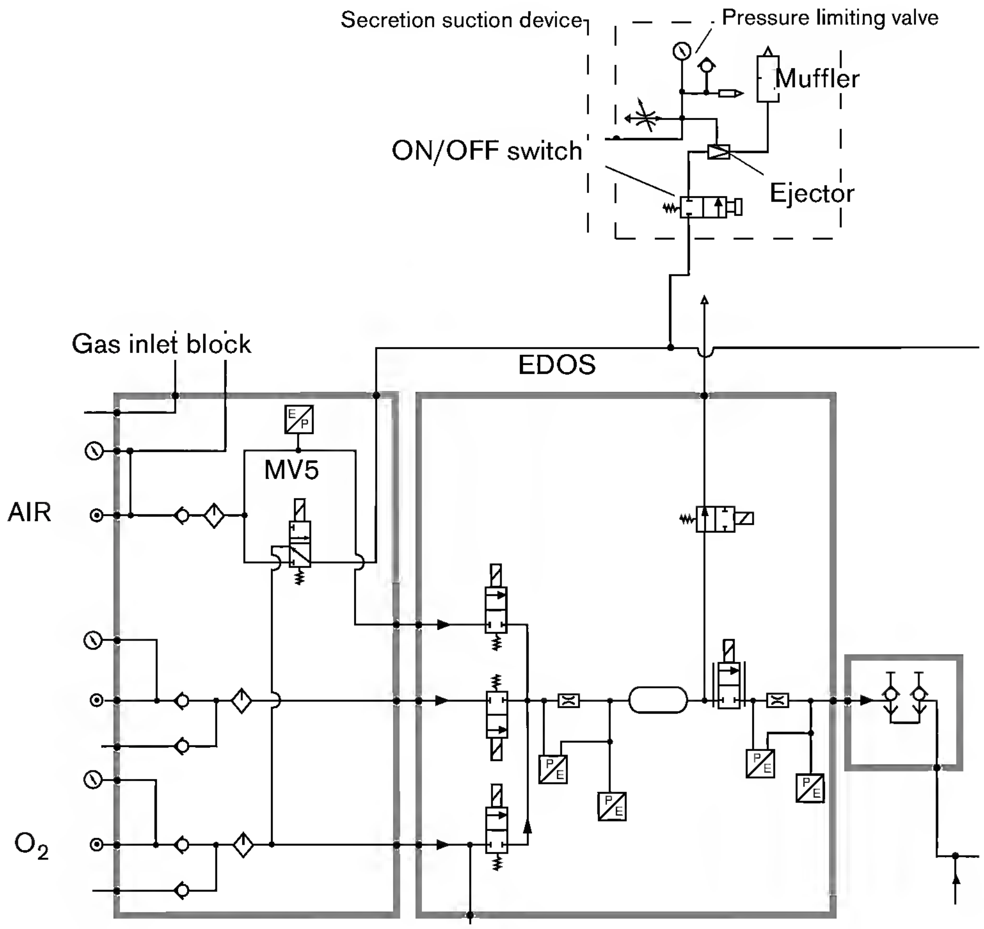


Fig.151: Secretion suctioning via ejector

65.2 Secretion suctioning via ejector with AIR (from 09/2000)

The secretion suction device is marked with "VAC" on a vacuum regulator.

The control and display elements of the secretion suction device are located on the control panel. The secretion suction device (including a secretion trap bottle and a flush bottle) is installed in a mount on one side of the trolley. Vacuum for the secretion suction device is generated by an ejector. The secretion suction device is powered by a controllable compressed-air ejector. AIR is used as driving gas (3.5 to 5 bar). A pressure relief valve limits the suction pressure in the secretion suction line.

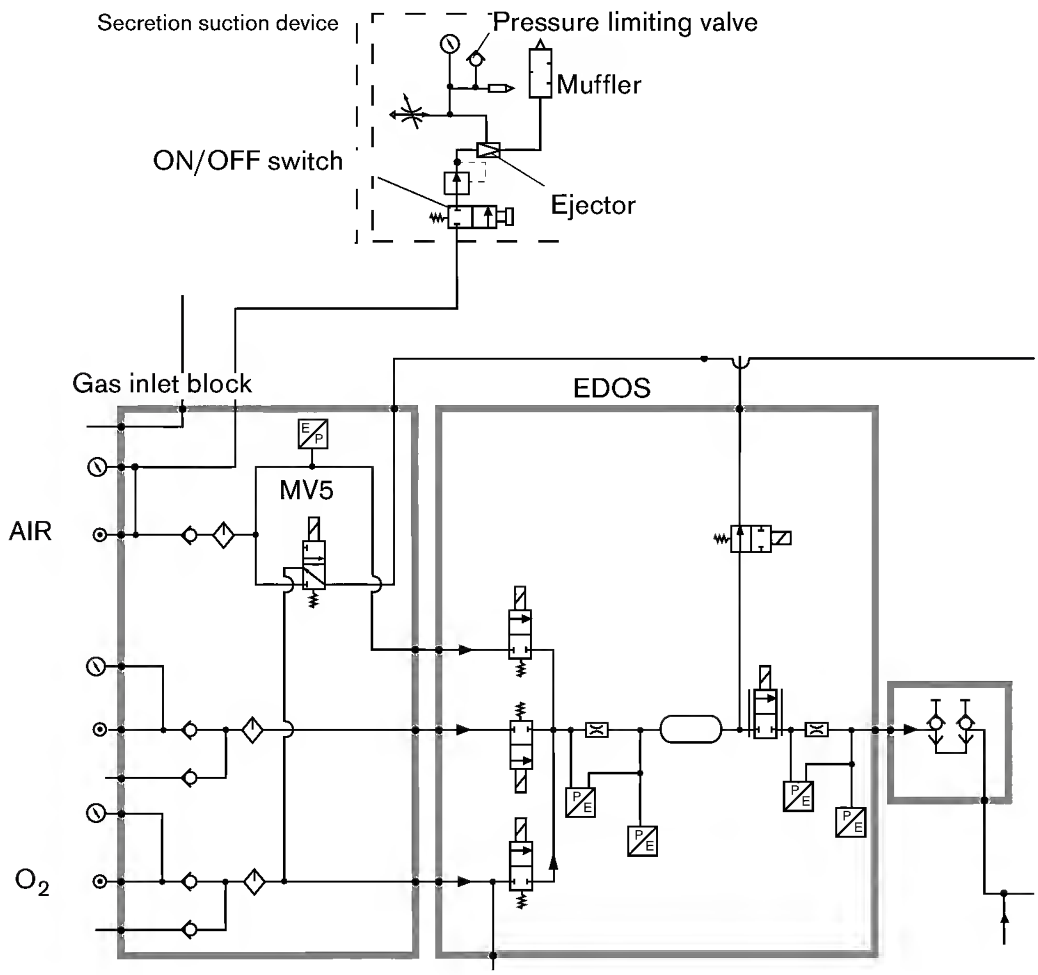


Fig.152: Secretion suctioning via ejector

65.3 Secretion suctioning via VAC connection (optional)

The vacuum for the secretion suctioning via the VAC connection is generated by an external source.

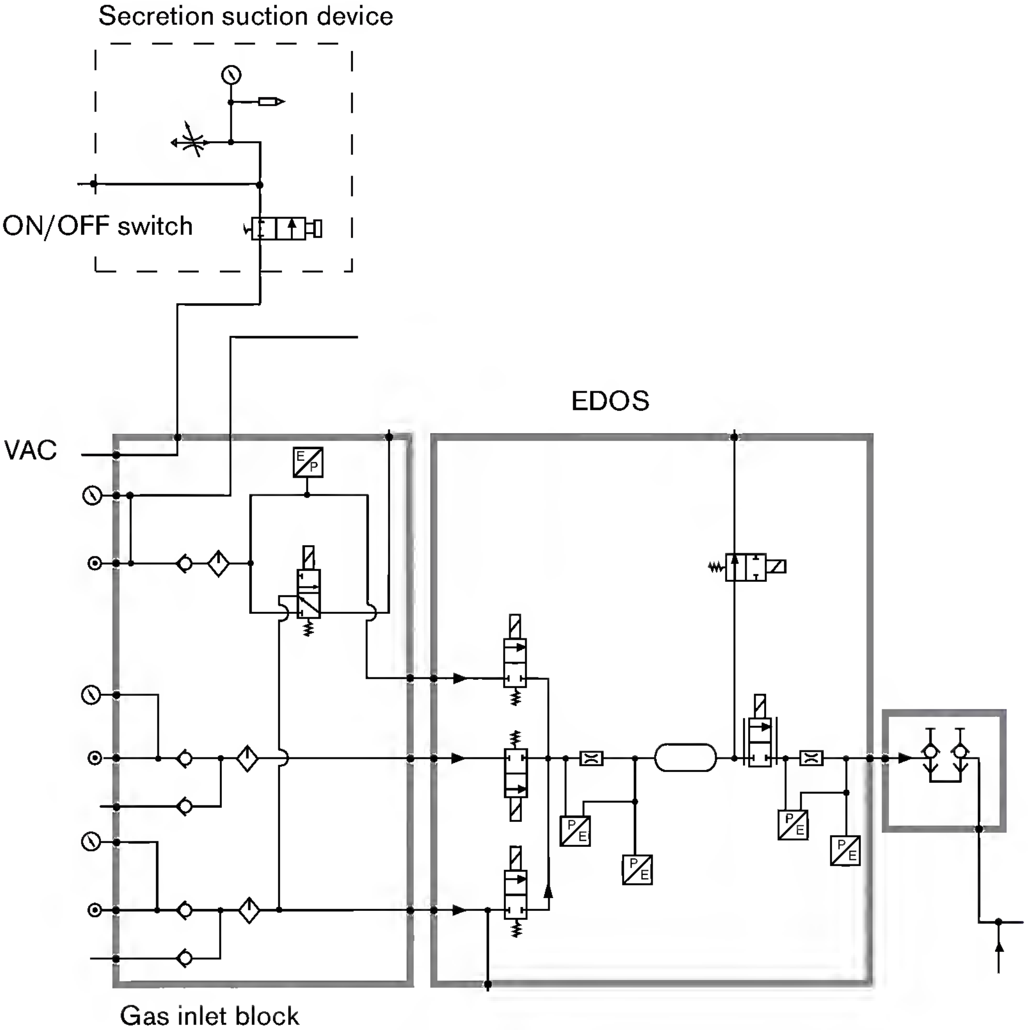


Fig.153: Secretion suctioning via VAC connection

66 Ventilator

The ventilator controls the bellows according to pre-set respiratory parameters. The ventilator has the following components:

– Slot valve

– 2/2-way valve (MV2-V2)

– PEEP/PIP valve (MV1)

– Valve (MV3)

66.1 Slot valve

A stepper motor drives the spindle of the slot valve. A bellows coupling is mounted between the stepper motor shaft and the spindle. The bellows coupling removes the lateral and the axial play of the spindle and, at the same time, ensures pre-loading of the components.

When Julian is switched on, the software moves the slot valve to the reference point. To travel to the reference point, the slide first rotates forward until it reaches its mechanical stop (the valve closes) and then rotates three turns backward (the valve opens). The reference point corresponds to a flow rate of 20 L/min at an high pressure of 1.8 bar.

This process is additionally monitored by two fork-type light-barriers arranged at a 90° angle. The disk located on the spindle has four quadrants. The fork-type light-barriers monitor the position of the slide by checking the disc's position on the quadrants.

The slot valves must turn 11 times in order to travel from one mechanical stop to the next. The stepper motor turns about 6 times within the operating range, which corresponds to a flow rate between 0 L/min and approximately 80 L/min.

– One step of the stepper motor (1.8°) corresponds to a change in flow rate of 66 mL/min.

– One full turn (360°) consists of 200 steps (it corresponds to a change in flow rate of 13.2 L/min).

– Six turns and a pressure of 1.8 bar result in a flow rate of 79.2 L/min.

Pressure sensor P_{vor} measures the pressure at the slot valve. The slot valve compensates for pressure fluctuations by re-adjusting the flow.

When the flow changes from "on" to "off", the position of the set value is reached directly. When the flow changes from "off" to "on", the slot valve travels past the set value and then returns.

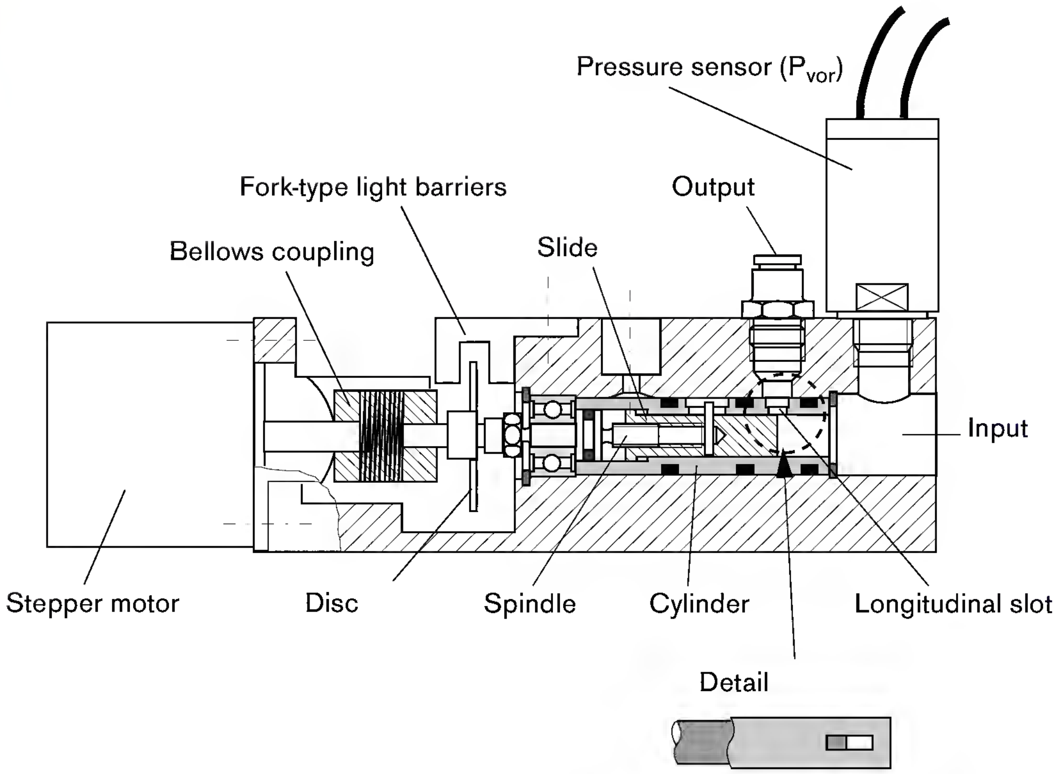


Fig.154: Slot valve

66.2 2/2-way valve (MV2-V2)

The 2/2-way valve subassembly consists of valve V2 (pneumatic) and valve MV2 (electrical). The 2/2-way valve assembly controls high flow rates and consumes less current. MV2 is closed when the current is zero and during expiration. Control gas flows into valve V2. Control gas flows also through a hole in the valve V2 diaphragm. This balances the pressure on both sides of the diaphragm. Since the diaphragm surface of chamber 2 is larger than that of chamber 1, the pressure in chamber 2 exerts a higher force on the diaphragm, thus keeping valve V2 closed. The spring supports this effect (see Fig. 155: 2/2-way valve closed). Chamber 2 is vented through the outlet only when valve MV2 opens. When this happens, the pressure in the two chambers is no longer balanced. As a result, valve V2 opens and control gas escapes through the outlet (see "Fig. 156: 2/2-way valve open").

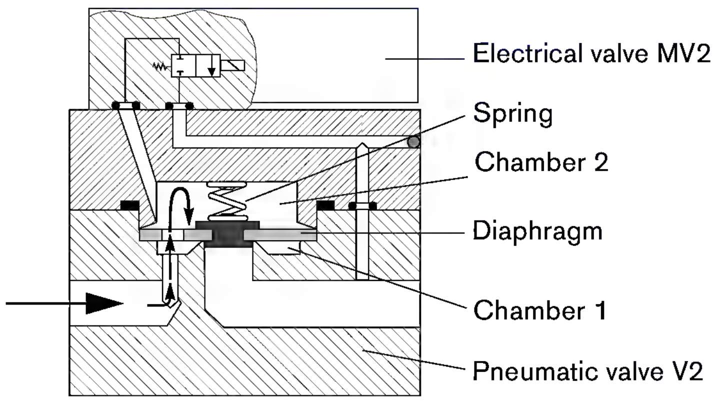


Fig.155: 2/2-way valve closed

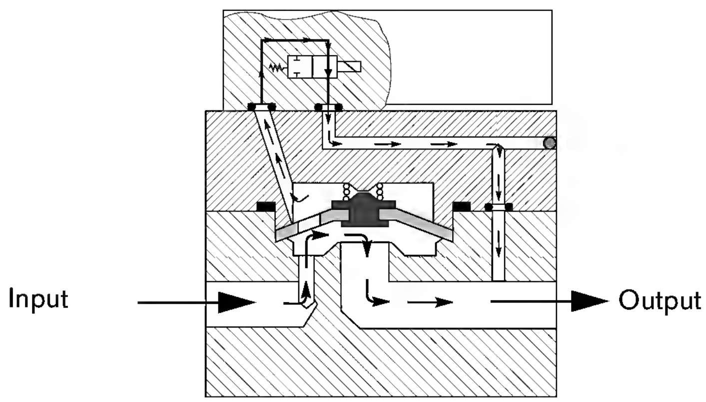


Fig.156: 2/2-way valve open

66.3 PEEP/PIP valve (MV1)

PEEP/PIP valve (MV1) is an electrically driven pressure regulator. Its adjustable control pressure ranges from −20 mbar to +100 mbar. The control pressure controls the positive inspiratory pressure (PIP) and the positive end-expiratory pressure (PEEP).

The plunger coil system of PEEP/PIP valve MV1 generates the required control pressure. An electromagnetic force moves the plunger in the plunger coil system. When current flows through the plunger coil system, the plunger moves from its starting position. It pushes the PEEP/PIP valve MV1 diaphragm against the crater closing PEEP/PIP valve MV1.

The ejector generates a negative control pressure of up to −20 mbar. PEEP/PIP valve MV1 controls valve V1. The negative control pressure generated allows the chamber to vent quickly.

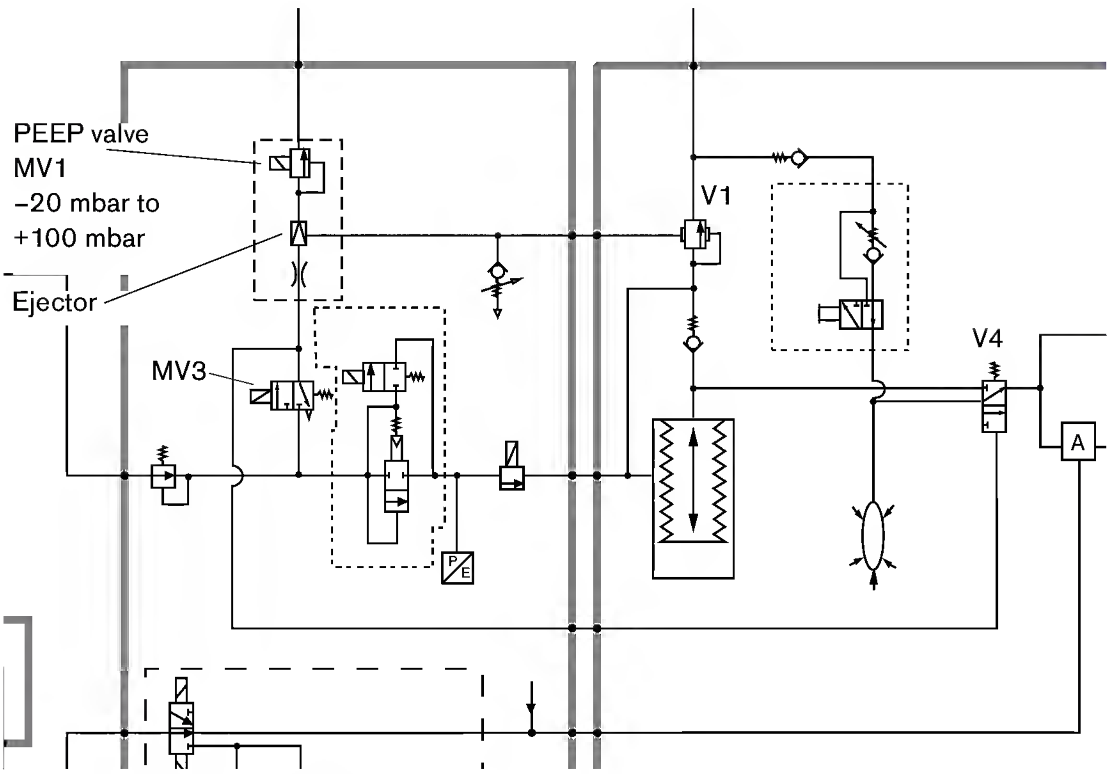


Fig.157: PEEP/PIP valve (MV1)

66.4 Valve (MV3)

Valve MV3 is actuated when Julian is switched on and the pneumatics are activated. Valve MV3 switches valve V4 to mandatory ventilation and supplies PEEP/PIP valve MV1 with control gas.

67 A-cone (optional)

67.1 General

Fresh gas is supplied through a fresh-gas hose to the breathing system and then to the patient. The A-cone provides an additional fresh-gas outlet. A valve enables switching between the A-cone and the fresh-gas outlet to the breathing system.

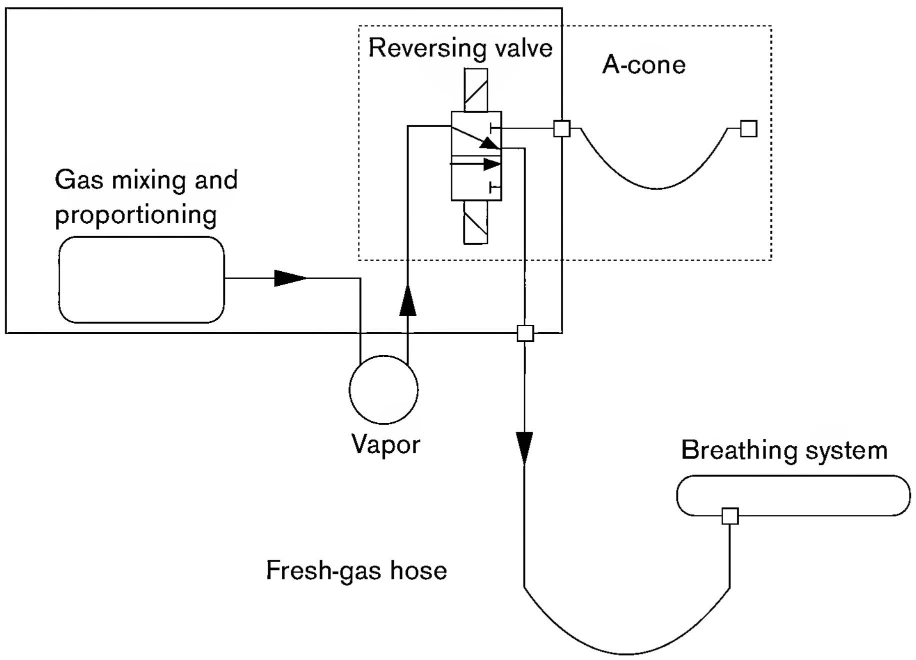


Fig. 158: Basic functional diagram of the A-cone

67.2 Function

The A-cone function is only active in the MAN/SPONT mode. The MV6 valve switches the internal fresh-gas outlet to external A-cone outlet. Safety valve $P_{si\ 80\ mbar}$ protects the patient from overpressures. When selecting IPPV or PCV, the MV6 valve switches the fresh-gas flow to the breathing system. The MV6 valve retains its position during a power loss; it does not return to a default position.

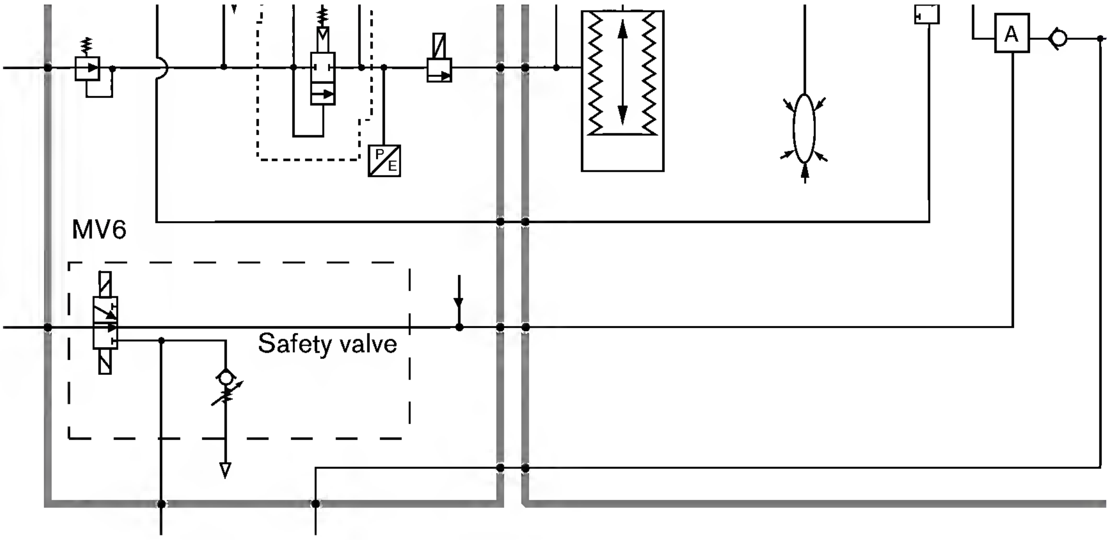


Fig.159: A-cone control

68 Breathing system

68.1 General

The breathing system provides the interface between the ventilator and the patient. The breathing system consists of the following components:

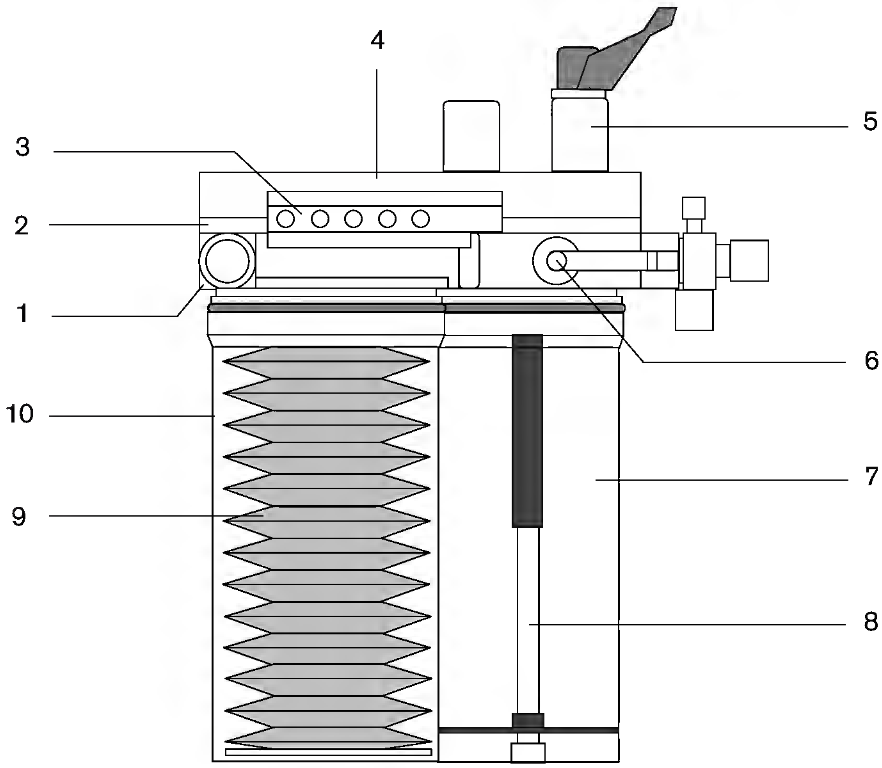


Fig. 160: Breathing system, complete

Key

1	Respiratory gas block	6	Flow sensor
2	Valve panel	7	Absorber canister
3	Connector block	8	Absorber insert
4	Valve cover	9	Bellows
5	APL valve	10	Pressure chamber

The respiratory gas block contains respiratory channels, the MAN/SPONT reversing valve V4, a PEEP valve seat, connections for respiratory hoses, the anesthetic gas scavenging connection, and a mount for the pressure chamber with bellows and an absorber canister. Control respiratory valves are integrated in the valve plate.

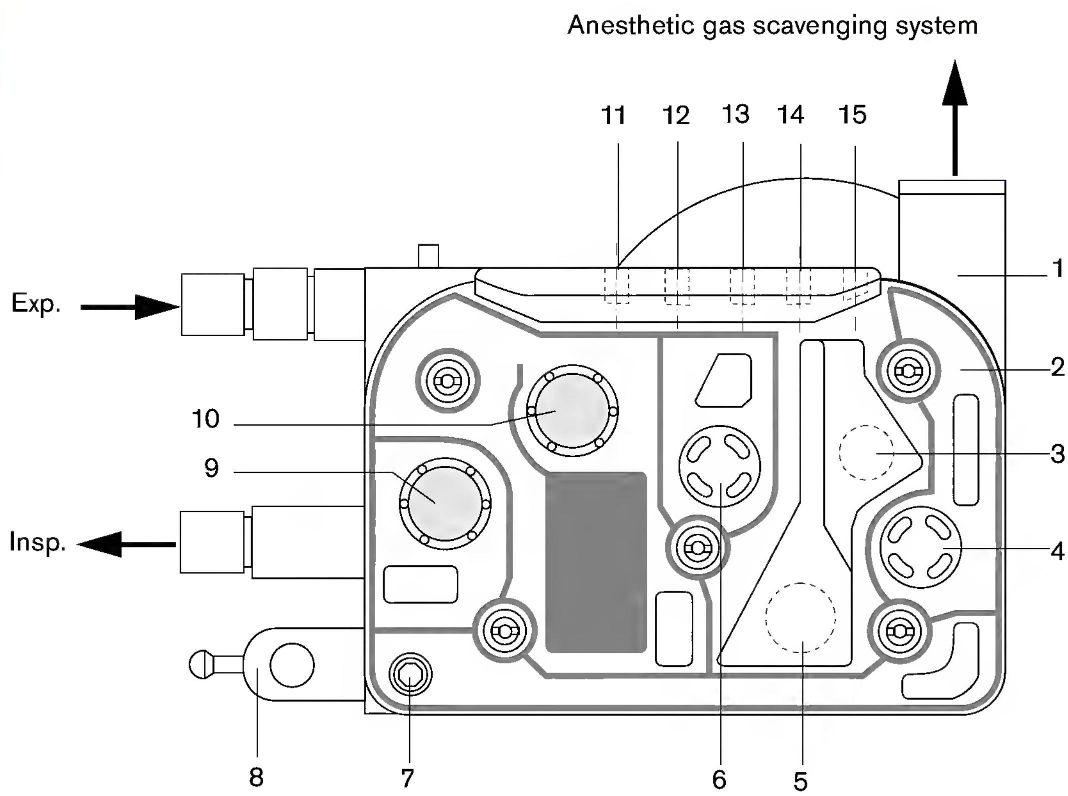


Fig.161: Breathing system, open (valve plate)

Key

1	Respiratory gas block	9	Inspiratory valve
2	Valve panel	10	Expiratory valve
3	PEEP valve (V1)	11	Pressure measurement channel
4	Check valve RV2	12	Fresh-gas channel
5	MAN/SPONT reversing valve V4	13	Driving-gas channel
6	Check valve RV1	14	Control channel V4
7	APL valve seat	15	PEEP/P_{max} control channel
8	Breathing bag connector		

68.2 Working principle

During manual ventilation, the patient is ventilated with the breathing bag. Fresh gas and expiratory gas flows through the absorber to the patient. The pressure limit for manual ventilation is set using the APL valve. Excess gas flows to the anesthetic gas scavenging system through a spring-loaded valve, RV2. During spontaneous breathing, the RV2 valve prevents the rebreathing of excess gas.

The patient is supplied with respiratory gas from the bellows during spontaneous breathing. Valve V1 limits the pressure of respiratory gas. Valve RV1 prevents driving gas from reaching the patient.

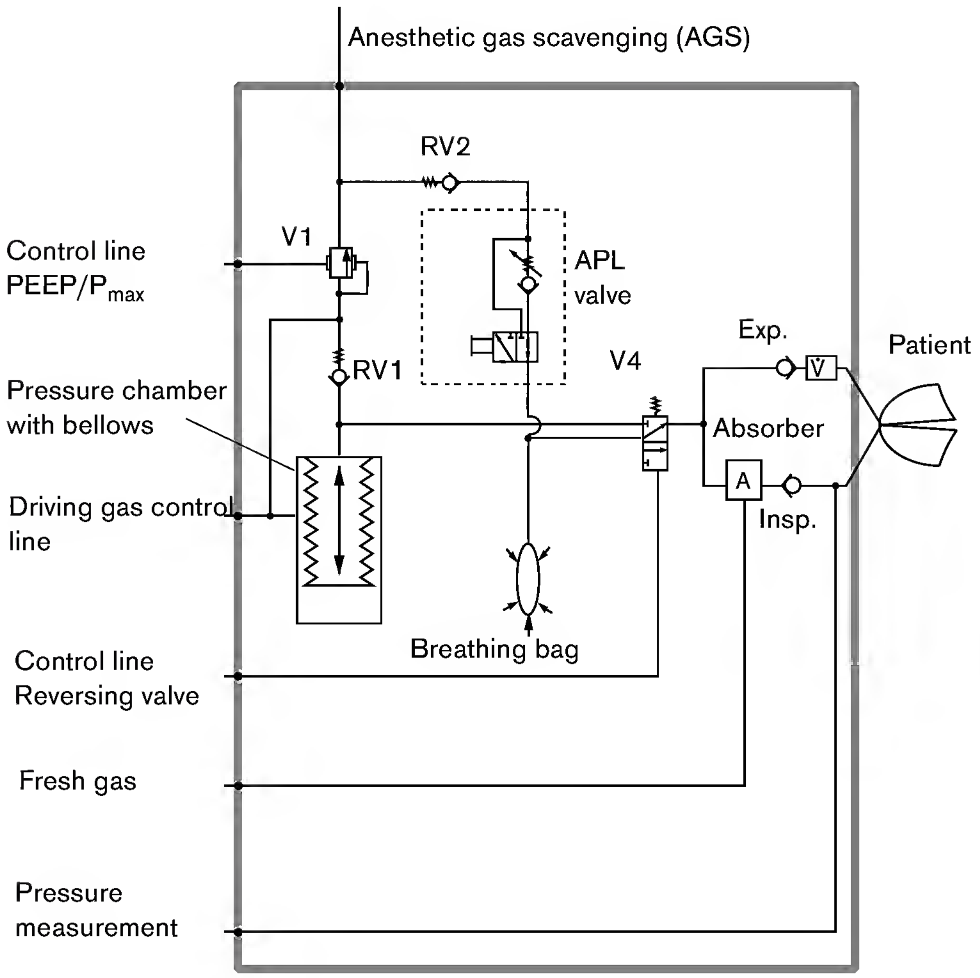


Fig.162: Breathing system

69 Ventilation modes

69.1 MAN/SPONT mode

All valves are de-energized in the MAN/SPONT mode. Pressure limit for manual ventilation is set using the APL valve. Excess gas flows to the anesthetic gas scavenging system through a spring-loaded valve, RV2. During spontaneous breathing, the RV2 valve prevents the rebreathing of excess gas.

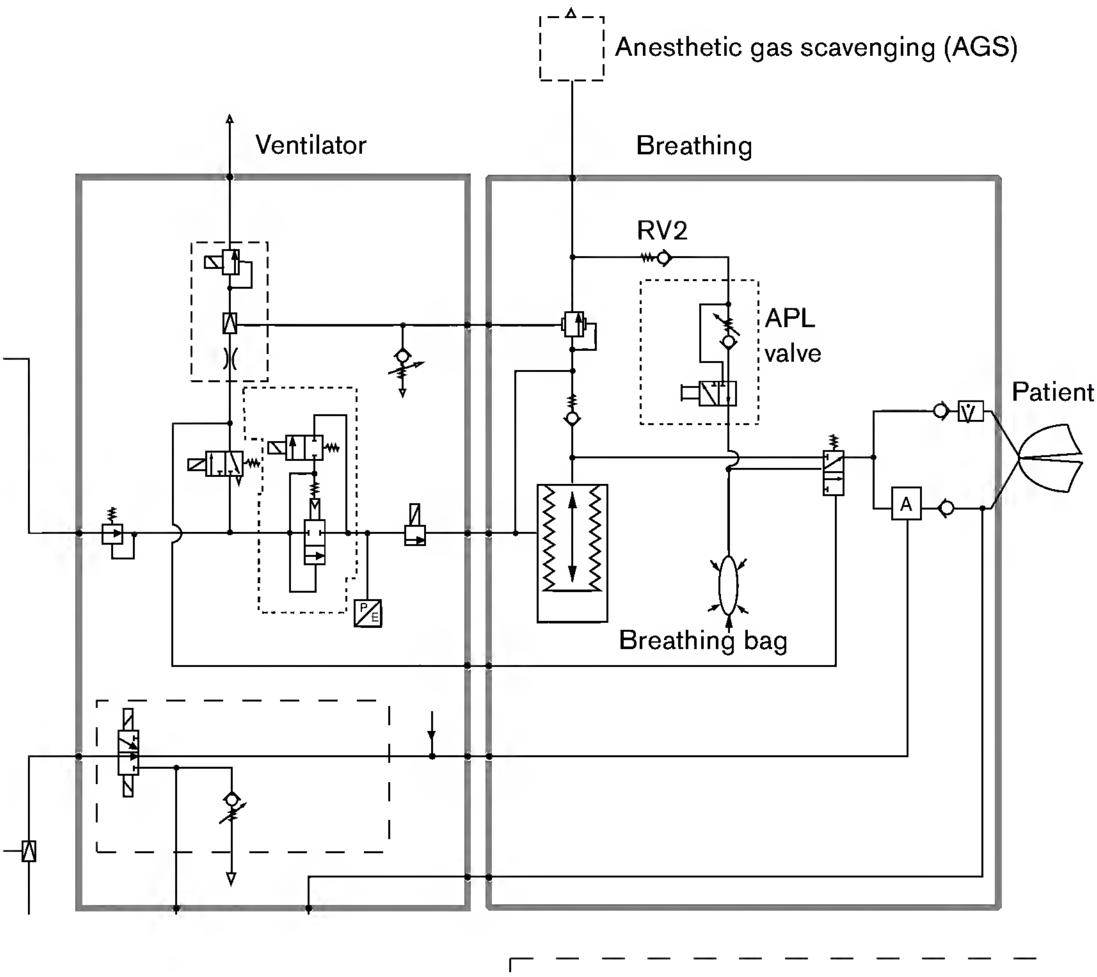


Fig.163: MAN/SPONT mode

69.2 IPPV mode

In the IPPV mode, valve MV3 actuates valve V4. Slot valve F is set to driving gas. Julian calculates the driving gas from the set ventilation parameters.

69.2.1 Inspiration flow phase

Valve MV1 is triggered using a specific current for P_{max} (it generates a control pressure which keeps valve V1 closed). Valve MV2 remains open during inspiration. It actuates valve V2 and allows the driving gas set at slot valve F to enter into the pressure chamber. The driving gas pushes the bellows upwards in relation to the set V_T. Gas flows to the patient through absorber A and the inspiratory valve. The spring-loaded check valve, RV1 prevents driving gas from reaching the patient. When the preset P_{max} is exceeded, driving gas flows to the anesthetic gas scavenging system through valve V1.

69.2.2 Inspiratory pause

Valves MV2 and V2 are closed. The V1 valve is still triggered with P_{max}. When the preset P_{max} is exceeded, driving gas or patient gas flows to the anesthetic gas scavenging system through valve V1.

69.2.3 Expiration flow phase

Valve MV1 valve is triggered using the current for the adjusted PEEP. The breathing system is depressurized. Driving gas from the pressure chamber and patient gas from the breathing system can flow to the anesthetic gas scavenging system through valve V1. The weight of the bellows generates a pressure difference between the inside and the outside which keeps check valve RV1 closed until the bellows reach the bottom of the pressure chamber. Only then can patient gas flow to the anesthetic gas scavenging system through check valve RV1 and valve V1. The spring in check valve RV1 supports this effect.

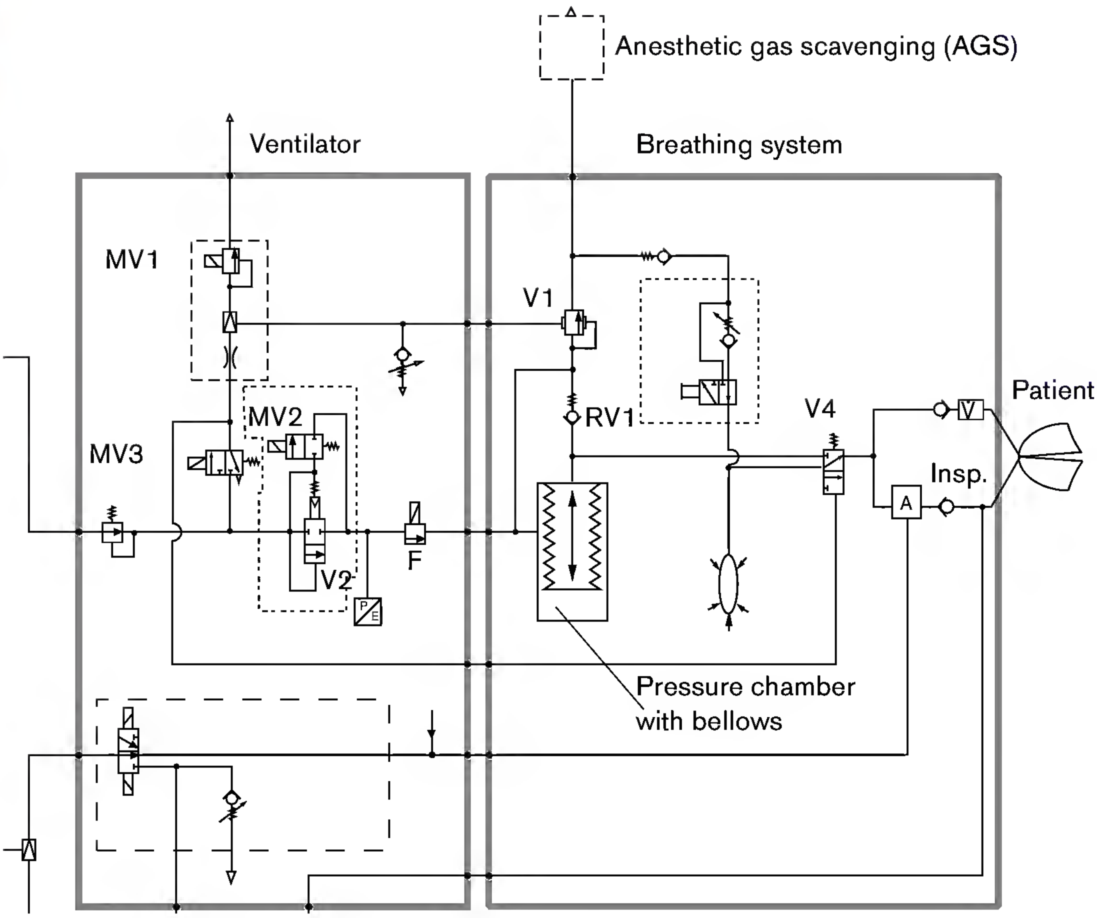


Fig.164: IPPV mode

69.3 PCV mode

In the PCV mode, valve MV3 actuates valve V4. Slot valve F is set to the user-set driving gas.

69.3.1 Inspiration

Valve MV1 is triggered using the current for P_{max} (it generates a control pressure which keeps valve V1 closed). Valve MV2 is open during inspiration. It triggers valve V2 and allows the driving gas set at slot valve F to flow into the pressure chamber. The driving gas moves the bellows until the set P_{max} is attained. It then flows to the anesthetic gas scavenging system through valve V1.

69.3.2 Expiration

Expiration takes place in the same way as described in the IPPV mode.

69.4 Compliance correction

If software version 2.0 or a later version is installed, Julian is able to carry out a compliance correction which compensates for volume "lost" in hoses and in the breathing system.

Julian determines the system compliance (hoses and breathing system) required later for compliance correction during the self test or standby leak test. Hose compliance has a fixed value of 0.4 mL/mbar.

The V_T set is delivered during the first breath. ΔP is calculated from end-expiratory pressure P1 and end-inspiratory pressure P2.

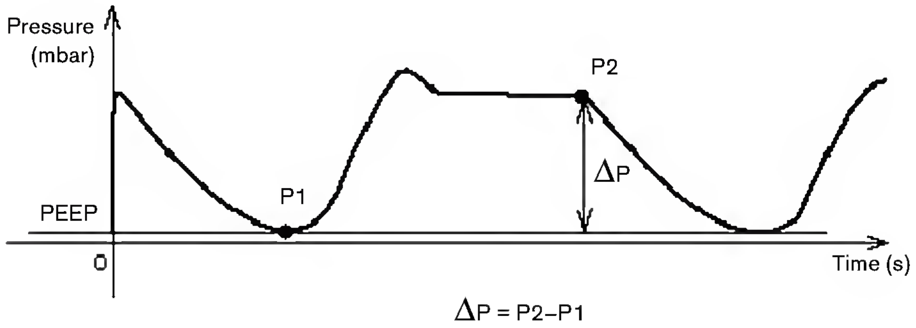


Fig.165: Pressure values

Having the system compliance (C_{sys}) and ΔP, Julian can calculate which volume (ΔV) has been "consumed" by the system, or, in other words, which volume has not been delivered to the patient.

$\Delta V = C_{sys} \times \Delta P$

Julian increases the volume to be delivered by the value ΔV.

$V_{T\ corr} = V_T + \Delta V$

Julian repeats this procedure during each breathing phase so that the V_T delivered to the patient gradually approaches the set V_T. This procedure is completed as soon as the plateau value stops changing ($\pm$0.5 mbar).

The displayed flow and the resulting values (for example, MV) are updated accordingly.

69.4.1 Example of a compliance correction procedure

We assume that Julian has calculated a system compliance of C_{sys} = 4 mL/mbar during the self test. The volume to be delivered to the patient shall be V_T = 600 mL. The system (breathing system hoses, patient) is supplied with 600 mL during the first mandatory breath. The resulting pressure is $\Delta P1$ = 30 mbar.

Julian uses these values to calculate the total compliance:

$$C_{Total} = \frac{V_{T1}}{\Delta P_1} = \frac{600\ \text{mL}}{30\ \text{mbar}} = 20\ \text{mL/mbar}$$

This results in the following patient compliance:

$$C_{pat.} = C_{total} - C_{sys} = 20\ \text{mL/mbar} - 4\ \text{mL/mbar}$$

$$C_{pat.} = 16\ \text{mL/mbar}$$

The patient is supplied with a volume of 480 mL.

$$V_{pat.1} = C_{pat.} \times \Delta P1 = 16\ \text{mL/mbar} \times 30\ \text{mbar}$$

$$V_{pat.1} = 480\ \text{mL}$$

The error (deviation from the set value) is calculated as follows:

$$V_{error\ 1} = V_{T1} - V_{pat.1} = 600\ \text{mL} - 480\ \text{mL} = 120\ \text{mL}$$

In order to correct this error, Julian increases the volume supplied by the slot valve by $V_{error\ 1}$.

$$V_{T2} = V_{T1} + V_{error\ 1} = 600\ \text{mL} + 120\ \text{mL}$$

$$V_{T2} = 720\ \text{mL}$$

Julian supplies the new V_{T2} during the second mandatory breath.

$$\Delta P_2 = \frac{V_{T2}}{C_{total}} = \frac{720\ \text{mL}}{20\ \text{mL/mbar}} = 36\ \text{mbar}$$

The patient is supplied with a volume of 576 mL.

$$V_{pat.2} = C_{pat} \times \Delta P_2 = 16\ \text{mL/mbar} \times 36\ \text{mbar} = 576\ \text{mL}$$

Error 2 is calculated as follows:

$$V_{error\ 2} = V_{T1} - V_{pat2} = 600\ \text{mL} - 576\ \text{mL} = 24\ \text{mL}$$

In order to correct this error, Julian increases the volume supplied by the slot valve by V_{error2}:

$$V_{T3} = V_{T2} + V_{error2} = 720\ \text{mL} + 24\ \text{mL} = 744\ \text{mL}$$

Julian supplies the new V_{T3} during the third mandatory breath.

$$\Delta P_3 = \frac{V_{T3}}{C_{total}} = \frac{744\ \text{mL}}{20\ \text{mL/mbar}} = 37{,}2\ \text{mbar}$$

The patient is supplied with a volume of 595.2 mL.

$$V_{pat.3} = C_{pat.} \times \Delta P_3 = 16\ \text{mL/mbar} \times 37.2\ \text{mbar}$$

$$V_{pat.3} = 595.2\ \text{mL}$$

Error 3 is calculated as follows:

$$V_{error\ 3} = V_{T1} - V_{pat.3} = 600\ \text{mL} - 595.2\ \text{mL} = 4.8\ \text{mL}$$

Julian repeats this procedure during each breathing phase.

69.5 Monitoring and control

Pressure is measured at P_{vor} upstream of slot valve F during inspiration. If the pressure exceeds 1.4 bar, the opening of slot valve F is adjusted. If the pressure is below 1.4 bar or exceeds 2.3 bar, Julian switches to the MAN/SPONT mode.

If the high pressure measured by P_{vor} during the inspiratory pause or during expiration exceeds 0.3 bar (valve V2 is closed), Julian switches the to MAN/SPONT mode.

During mandatory ventilation in the IPPV mode, the set maximum pressure P_{max} is monitored by pressure sensor P_{aw}. If the pressure exceeds the maximum pressure P_{max} by 5 mbar, Julian switches to the MAN/SPONT mode. PEEP is regulated between −5 mbar and +5 mbar.

During ventilation in the PCV mode, the set maximum pressure P_{max} is regulated between −2 mbar and +2 mbar. If the upper limit value is exceeded, Julian switches to MAN/SPONT. If pressure decreases below the lower limit, Julian generates an alarm message.

69.5.1 "Fresh gas low" alarm

The new version of Julian (software version 2.0 or later) is equipped with means to detect insufficient fresh-gas flow. This is accomplished by monitoring the end position of the bellows.

A photoelectric system monitors the bellows' movement. If the bellows do not reach the end position (bottom of the pressure chamber), Julian issues a "fresh gas low" warning.

The photoelectric system and the bellows are tested for proper functioning during the power-on test. The bellows are moved upwards. The optical emitter is switched on and off several times, and the response of the photodetector is checked each time. On/off procedure is repeated several times in order to compensate for interference by irradiation from external light sources. The optical emitter is then switched on, the bellows are moved downwards, and the response of the photodetector is checked. If the light beam has been disturbed, the bellows are in the right position.

The photoelectric system is mounted on a plate located in the pneumatics assembly. The optical emitter is connected with the Mixing Valve Adapter PCB. Whereas the photodetector is connected with the Actuator PCB. When the breathing system is installed, the bellows will be located exactly between the optical emitter and the photodetector of the photoelectric system.

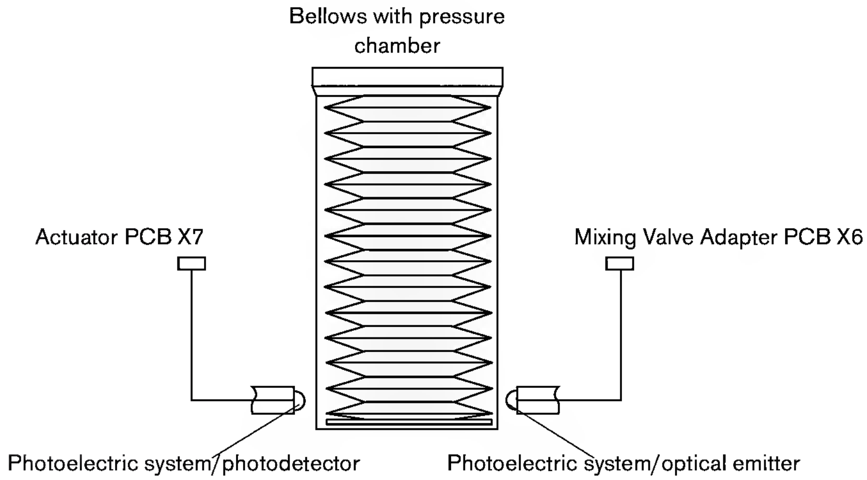


Fig.166: Photoelectric system, "Fresh gas low" warning

Photoelectric system status

Status of optical emitter	Status of photodetector	Result	Remark
Off	Off	o.k.	No irradiation from external light sources or photoelectric system deactivated.
Off	ON	not o.k.	Irradiation from external light sources
ON	Off	o.k. sufficient fresh gas available	Photoelectric system must be o.k. because power-on test was o.k.
ON	ON	Fresh gas low	If irradiation from external light sources can be excluded (see first remark above), fresh-gas flow is insufficient.

70 Pressure regulators/high-pressure gas cylinders

70.1 Intended use

Julian's pressure regulators are designed to provide an emergency supply with O_2 and N_2O from high-pressure gas cylinders if the pipeline system fails, or to allow the use of high-pressure gas cylinders as the main gas supply if a pipeline system is not available.

70.2 Description

The pressure regulators are plunger-type, single-stage pressure regulators with gas-specific and country-specific high-pressure connections and hose connections with gas-specific, non-interchangeable screw-threaded (NIST) connections on the low-pressure side.

General requirements as per prEN 738/1

CE0459

70.3 Representation

Pressure regulator with screw-threaded high-pressure connection
Country-specific versions:

Gas type	Code
O_2	G3/4 GA GB-HS GO GC-HT

Pressure regulator with pin-indexed high-pressure connection
Gas types: O_2 and N_2O

Gas type	Code
N_2O	G3/4 A G3/8 GH GX GI

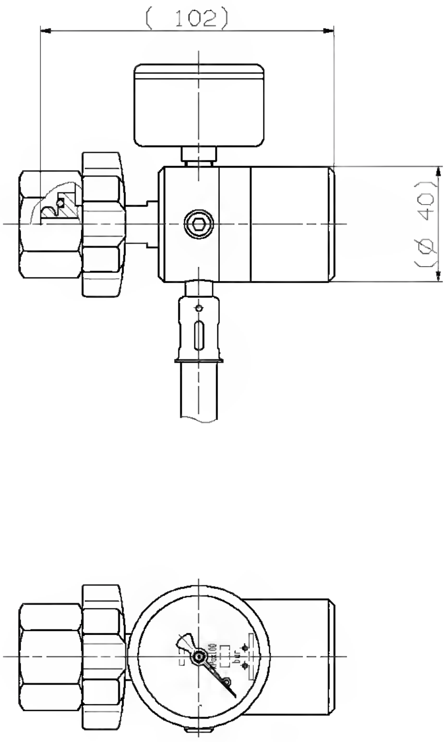


Fig.167: Pressure regulator with screw-threaded high-pressure connection

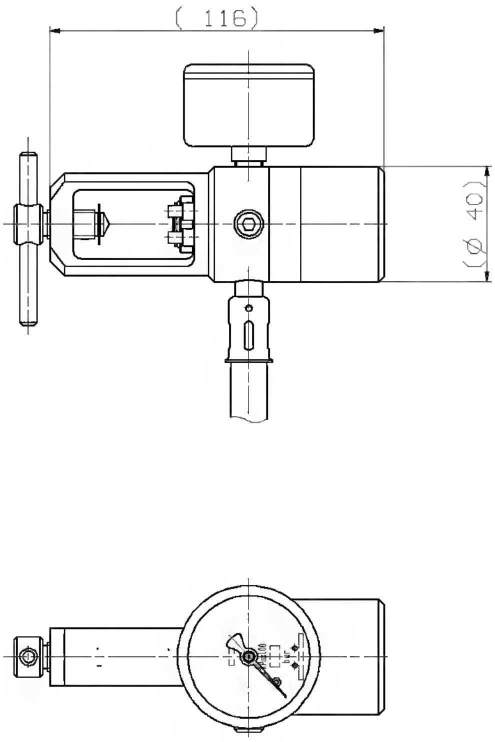


Fig.168: Pressure regulator with pin-indexed high-pressure connection

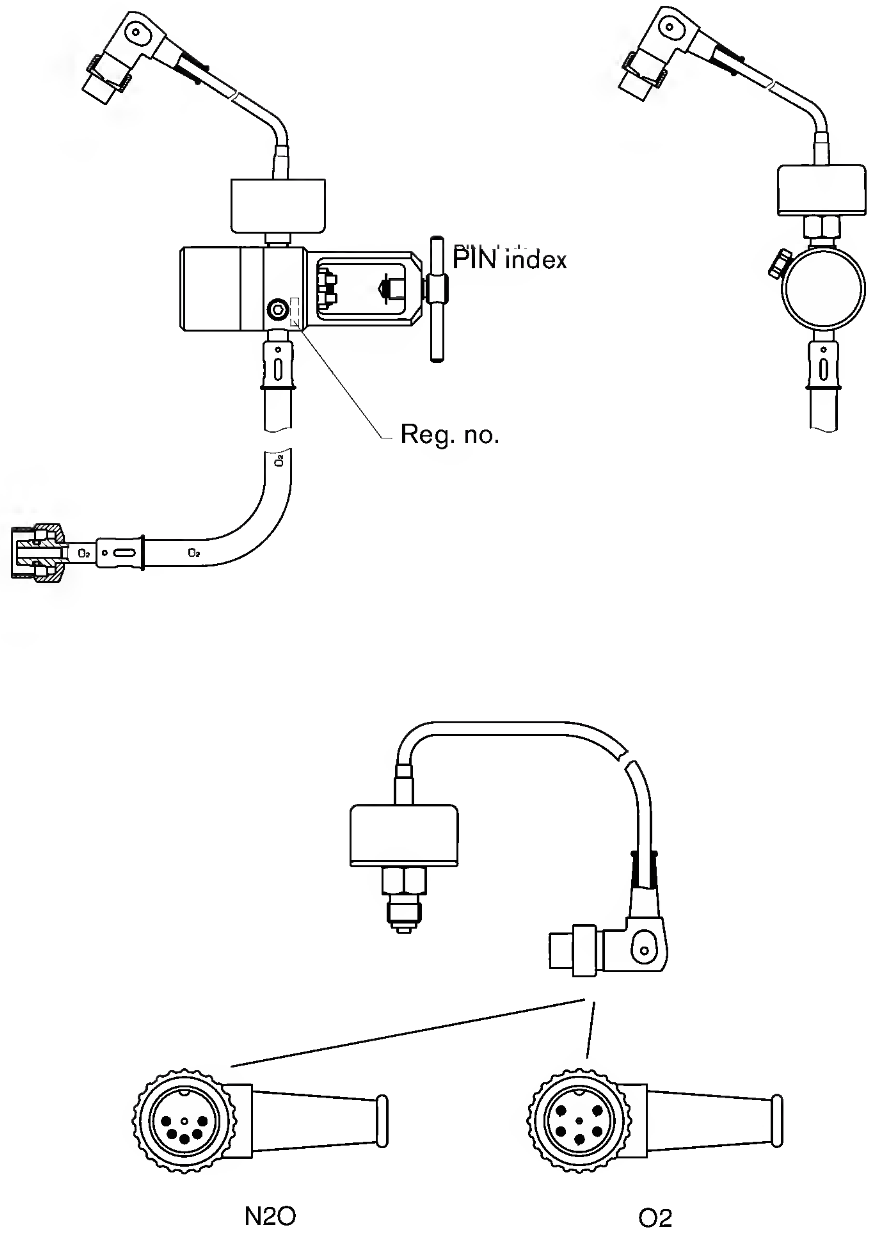


Fig. 169: Pressure regulators (US version) with electronic pressure sensors

70.4 Connections

High pressure

General

- Flow restrictor to prevent pressure surges.
- Use only lubricants and seals for high pressure from list of materials/makes approved by regulatory authorities.

Threaded connection

Preferred widths across flats: 22 mm/32 mm

Oxygen (O_2)

ISO 228/1-G3/4: suitable for side fitting as per connection 9 DIN 477 Part 1
+ other country-specific connections:
Code GB-HS: Thread 22.91 x 1.814 SJ
Code GE: Thread .903" - 14 NGO -RH
Code GA: Thread W21.8 x 1/14"
Code GC-HT: Thread G5/8" (= R5/8" or W22.91 x 1/14")
Code GO: Thread BSP 5/8" (= R5/8")

Nitrous Oxide (N_2O)

ISO 228/1-G3/8: suitable for side fitting as per connection 11 DIN 477 Part 1
ISO 228/1-G3/4 A: suitable for side fitting as per connection 12 DIN 477 Part 1
+ other country-specific connections:
Code GH: Thread 21.75 x 1.814 SJ
Code GX: Thread .830" - 14 NGO - RH
Code GI: Thread W 11/16" x 1/20"

Pin-indexed U-clamp connection

Oxygen (O_2)

Clamp connection: suitable for gas cylinder valve no. 16.4 DIN 477 Part 8

Nitrous oxide (N2O)

Clamp connection: suitable for gas cylinder valve no. 16.7 DIN 477 Part 8

Low pressure

- One gas outlet on housing, pointing vertically downwards (90°)
- Integrated safety valve

70.5 Function

70.5.1 Pressure regulator

Components of the pressure regulator: see "Fig. 170: Sectional view of pressure regulator".

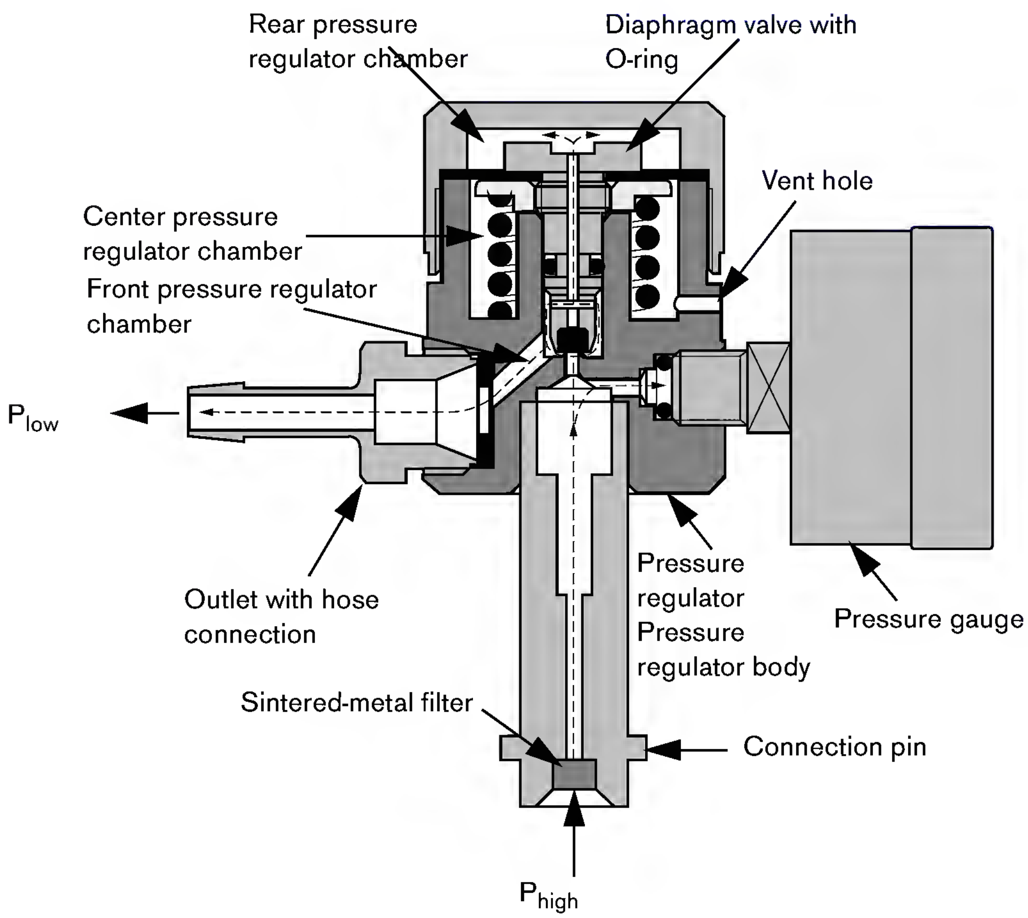


Fig.170: Sectional view of pressure regulator

High-pressure gas P_{high} from the cylinder flows through the connection pin into the pressure regulator body. The gas path branches off into one gas duct to the pressure gauge of the pressure regulator (or to the sensor in the USA version) and into a second gas duct to the valve plug of the pressure regulator.

The pressure gauge (or the digital display on the front panel) indicates the cylinder pressure P_{high}.

From the valve plug, the gas flows into the front pressure regulator chamber. The front pressure regulator chamber contains a closing pin. A sealing washer is mounted on the end of the closing pin. When the closing pin and the sealing washer are pressed against the valve plug, the gas flow will be partially or completely interrupted. A reduced low pressure Plow is generated. The front pressure regulator chamber is connected by lateral holes to the two possible outlets of the pressure regulator (G3/8" and M10 x 1) and to the safety valve.

The closing pin has a transverse bore. The transverse bore leads into a duct which interconnects the front and rear pressure regulator chambers. The rear pressure regulator chamber is pneumatically sealed by the diaphragm and the pressure regulator housing.

An O-ring is located in the center of the closing pin. This O-ring provides a seal between the closing pin and its guide. The center pressure regulator chamber is located between this O-ring and the diaphragm. A spring is inserted between the diaphragm mount and the pressure regulator body. The center pressure regulator chamber is linked to the ambient atmosphere via a hole. As a direct result, the pressure in this chamber can equalize itself with the ambient pressure of the pressure regulator.

If P_{high} is equal to the ambient pressure (cylinder valve closed), the spring is unloaded and the valve of the pressure regulator valve thus opened. The low pressure Plow of the pressure regulator is then equal to the high pressure P_{high}.

If P_{high} is greater than the ambient pressure (cylinder valve open), Plow adjusts until the diaphragm is in a state of equilibrium.

The low pressure of the pressure regulator is determined by the spring force.

70.5.2 Safety valve

For the function principle of the safety valve see "Fig. 171: Sectional view of the safety valve".

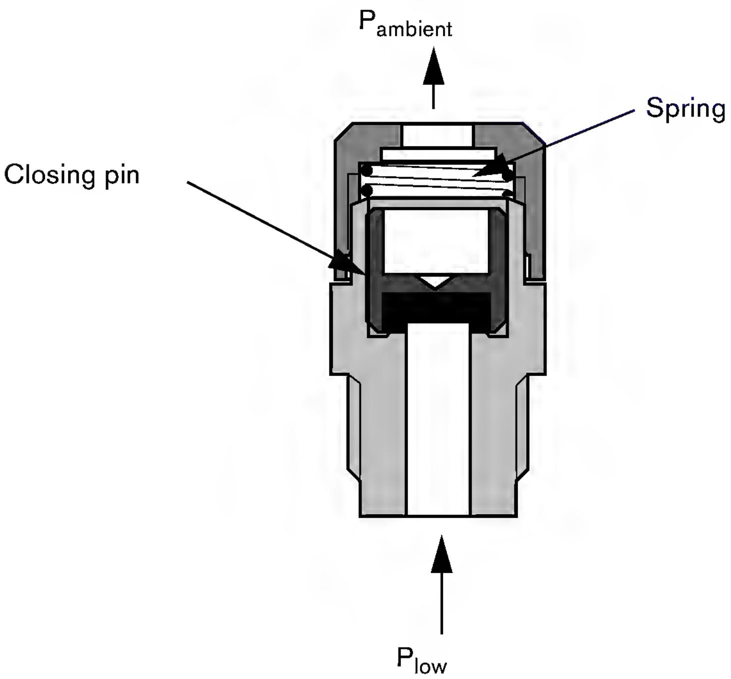


Fig.171: Sectional view of the safety valve

The safety valve is designed to limit low pressure to a maximum value P_{max}.

Low pressure P_{low} of the pressure regulator is applied through a duct from the front pressure regulator chamber to the closing pin of the safety valve.

From the other side, the closing pin is pressed against a seal by a spring.

The safety valve remains closed as long as the low pressure P_{low} is less than the maximum value P_{max}.

If low pressure P_{low} is equal to or greater than the maximum value P_{max}, the safety valve opens. Gas is vented to ambient atmosphere until low pressure P_{low} is less than maximum value P_{max}.

Function Description

Electronics

Contents:

71 General

Julian is a multi-functional anesthetic machine designed for

- inhalational anesthesia with partial rebreathing systems
- inhalational anesthesia with "quasi-closed" systems using low-flow or minimum-flow techniques for reduced consumption of gases and anesthetics
- intermittent positive pressure ventilation (IPPV)
- pressure control ventilation (PCV)
- manual ventilation (MAN)
- spontaneous breathing (SPONT)

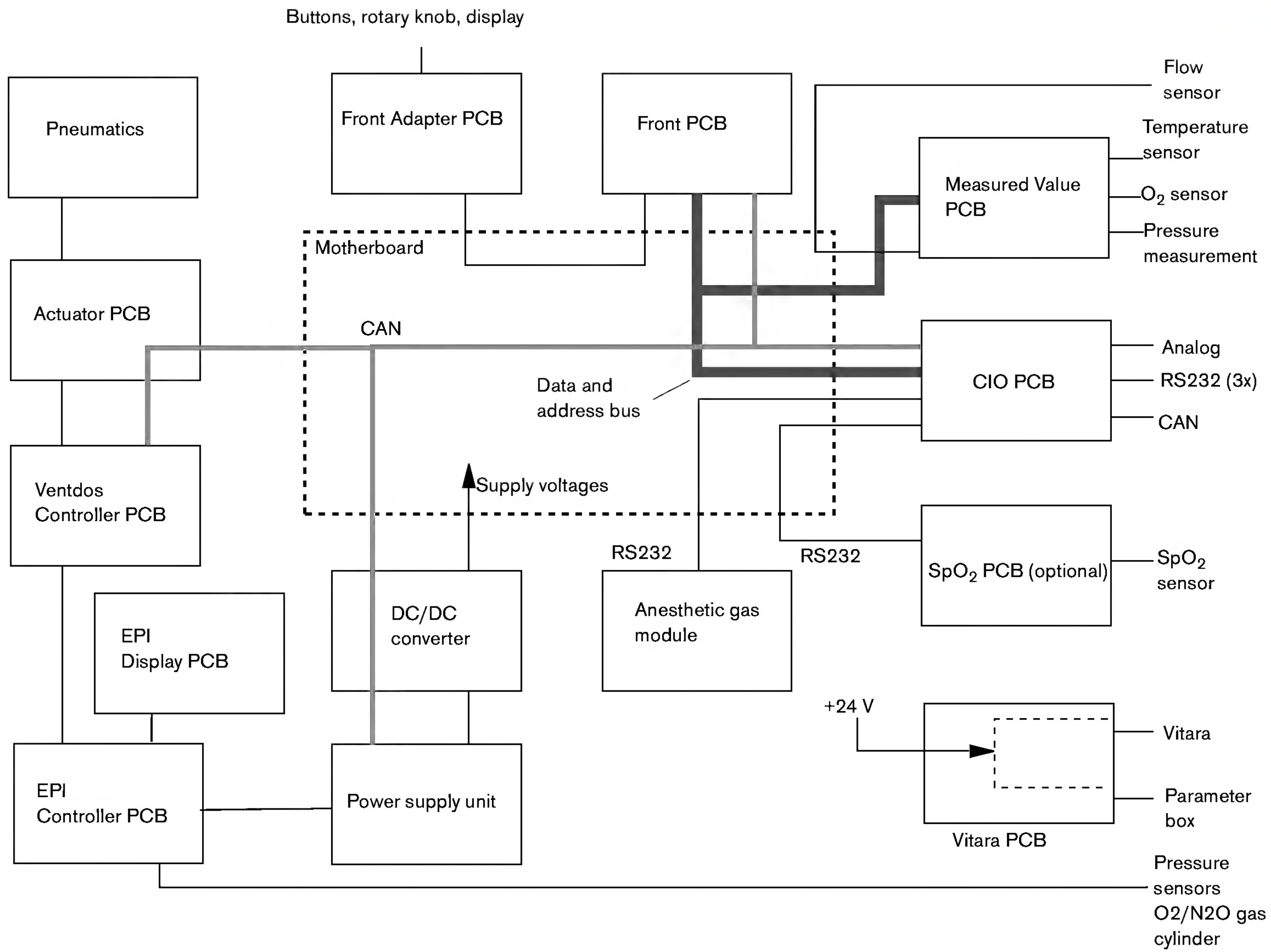


Fig.172: Block diagram of Julian

73 CIO PCB

The CIO PCB is the central processor of Julian. It contains the following subassemblies/components:

- processor system with flash EPROM (electrically programmable and erasable read-only memory)
- power failure logic
- clock module
- LEDs and internal communication driver modules
- various interfaces

The 68332 microcontroller program is stored in the flash EPROM. This program can be installed using a service PC. It is not necessary to disassemble Julian in order to install new software.

A power supply failure while loading the program can erase the initial program loader (the initial program loader is required to download the software via the RS232 interface). In such a case, software must be loaded via the debug interface.

The flash EPROMs have a 2MB storage capacity. The RAMs have a 512 KB storage capacity, 256 KB of which are battery-backed.

During power-on, the CIO PCB loads the programs for the other printed circuit boards into the respective RAMs. The printed circuit boards are then reset and initialized from their own RAMs.

Customer settings (screen layout) and the pressure sensor calibration value are stored in battery-backed RAM. The battery ensures that this data remains stored in memory when Julian is switched off.

The power failure logic evaluates the power switch position (ON or OFF). If the power supply fails or if the backup battery system (power supply unit) is discharged, Julian will generate a an audible power failure alarm for 30 s. A high-capacity Goldcap capacitor powers the alarm sound generator. The microcontroller is then reset and the "powerfail" signal from the power supply unit triggers an interrupt.

The CIO PCB communicates with internal devices via

- an internal RS232 interface
- an internal bus
- an internal CAN interface

Communication with external devices is ensured via

- three RS232 interfaces (COM1 through COM3)
- one CAN interface

There are also 3 analog outputs with a voltage level of 0 V to 4.095 V (Imax = 5 mA). Three trigger outputs with HCMOS level (HCMOS = high-speed complementary metal-oxide semiconductor) are used to trigger alarm recorders.

External interfaces, internal CAN interface, and analog outputs are electrically isolated. Two DC/DC converters generate the +5 V supply voltage needed to create this electrical isolation.

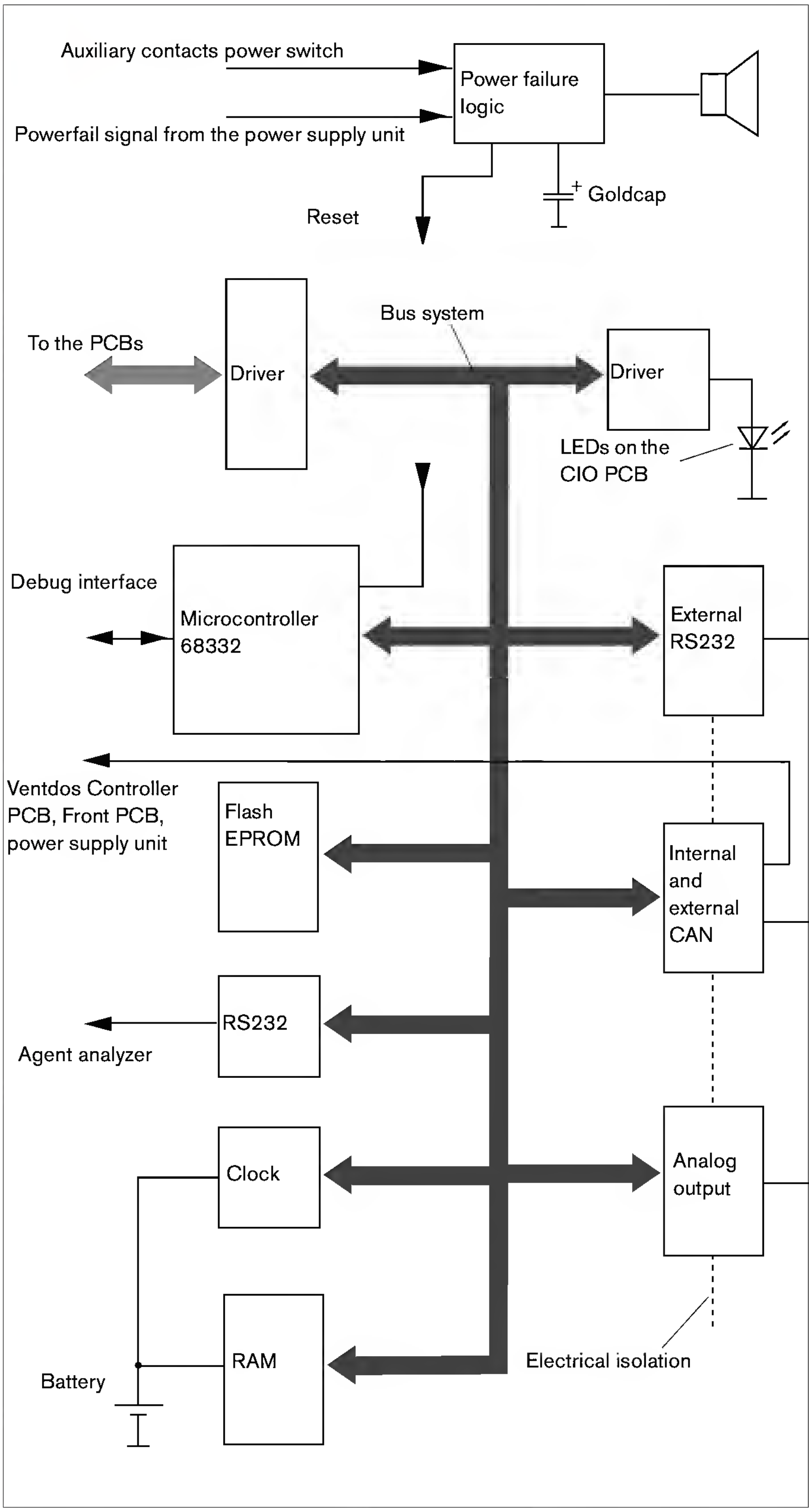


Fig.173: CIO PCB block diagram

74 Measured Value PCB

The Measured Value PCB measures the following:

– flow
– airway pressure
– O_2
– temperature

The Measured Value PCB processes analog signals from sensors and converts them to digital data. The multiplexer transmits one analog signal each (for example, pressure) to an A/D converter. The A/D converter converts the analog signal to digital data. The Z80 processor (Z80) uses this data to calculate the respective parameters which are stored in the dual port RAM located on the Measured Value PCB.

Z80 is the “control unit”. It calculates the airway parameters Peak, PEEP, Plat, V_T, MV, flow, temperature, FiO_2, and FeO_2.

The main processor on the CIO PCB retrieves the parameters from the dual port RAM and outputs them, for example, onto the display. The dual port RAM provides the interface between Z80 of the Measured Value PCB and the 68332 microcontroller of the CIO PCB.

RAM is used as program memory because the Measured Value PCB is not equipped with an EPROM. During the power-on self test, the 68332 microcontroller of the CIO PCB loads the program for Z80 into the RAM. Z80 initializes operation from the RAM.

The Measured Value PCB generates the “apnea” alarm.

74.1 Pressure Measurement

Airway pressure is measured by a differential pressure sensor. It functions according to the piezoelectric pressure transducer principle (transducer resistance varies according to pressure). The pressure sensor is located on a pressure module. The pressure module supplies a linear output voltage of 0.11 V to 2.45 V at a pressure range of –20 mbar to 100 mbar.

74.2 Temperature Measurement

Respiratory gas temperature is measured by an NTC resistor (NTC = negative temperature coefficient). The NTC resistor is specified as follows:

– 30 °C = 42.85 kohms

– 41 °C = 34.38 kohms

– Linearity = 770 ohms/K

The voltage measured by the NTC resistor is applied to a temperature hybrid which provides the following output voltages:

– 30 °C = 1.4333 V

– 41 °C = 0.7535 V

74.3 Flow Measurement

74.3.1 Measurement Principle

The flow sensor functions according to the constant-temperature hot-wire anemometer principle. Respiratory gas flows past a thin platinum wire. This platinum wire is located in a measuring tube and is electrically heated. The platinum wire is held at a constant temperature of 180 °C. The gas flow removes heat from the hot platinum wire: the higher the flow rate the greater the heat removal. The amount of electrical current required to maintain a constant platinum wire temperature is proportional to the gas flow rate.

A second heated platinum wire is used to compensate for interferences from different gases present in the respiratory gas. The heat removed from the second platinum wire is measured during inspiration when the gas flow is zero.

The different gases present in the respiratory gas have a different thermal conductivity. The amount of heat removed from the second platinum wire is an indicator of respiratory gas composition.

Internal calibration tables for O_2/N_2O mixtures, AIR and 100% O_2 are used to linearize the measured flow.

74.3.2 Automatic Flow Calibration

In earlier versions, flow calibration needed to be carried out by hand. The flow sensor had to be removed and sealed with one hand in order to create a zero flow condition. The gas used in the sensor was ambient air. Now, flow calibration is carried out automatically during ventilation within a specific time range at the end of the expiratory phase. The agent analyzer measures gas composition in the sensor, thus allowing gas composition to be taken into account during calibration.

The measured calibration value is stored in RAM (of the CIO PCB) and used as an initial value when switching on the monitor. A new calibration value is measured during each breath and corrected, if required.

If O_2 supply fails (O_2 INOP) or if anesthetic gas measurement fails, calibration will not be corrected again. In this case, Julian uses the calibration value stored in RAM. To reflect this condition, flow measurement values on the display are “grayed”.

74.4 O_2 Measurement

74.4.1 Measurement Principle

Oxygen is measured with an O_2 sensor which functions according to the electrochemical (galvanic cell) principle. Oxygen diffuses through an ultra-thin Teflon membrane into the electrochemical cell and is reduced at the gold cathode (Au cathode) (reduction is a process during which oxygen is either completely removed from oxygen compounds or replaced with hydrogen). At the same time a lead anode (Pb anode) oxidizes. The result is lead oxide and water. The oxidation process consumes the lead anode thus affecting the life expectancy of the sensor. The Teflon membrane allows the oxygen to diffuse very quickly. For this reason, this type of sensor has a considerably faster response time than the old type of O_2 measuring cell used in the mainstream measurement technique.

The chemical reaction produces a current which is proportional to the partial pressure of oxygen in the gas (PO_2).

The chemical reaction is temperature-dependent. In order to compensate for temperature differences, a temperature-dependent resistor (thermistor) has been connected in parallel to the O_2 sensor.

The O_2 sensor functions as a current source and has a very high internal resistance. Together with that of the thermistor, internal resistance amounts to approximately 2 kΩ.

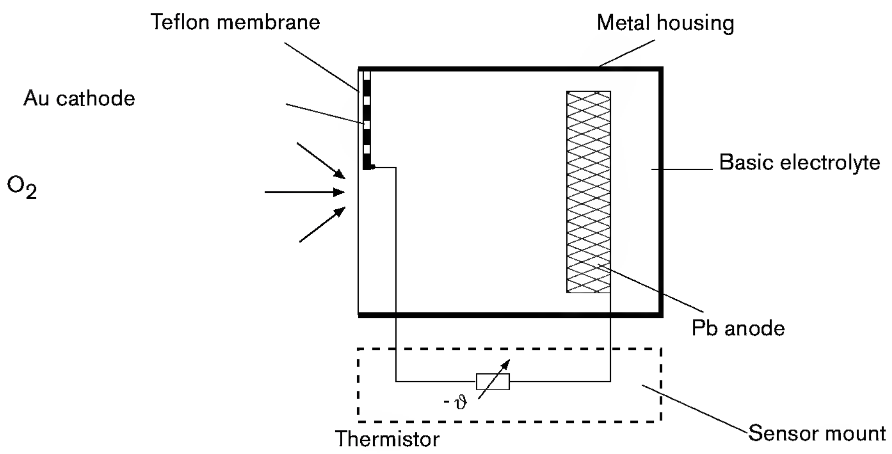


Fig.174: O_2 sensor measurement principle

74.4.2 Fast O_2 Measurement (Sidestream Measurement)

Fast O_2 measurement (also called sidestream measurement) requires a respiratory phase recognition function. The respiratory phase recognition function is ensured by the CO_2 signal from the agent analyzer. If an error occurs in the agent analyzer or if communication with the agent analyzer fails, the O_2 value may not be available or an O_2 INOP alarm (O_2 measurement inoperative) may occur.

The O_2 sensor supplies analog voltage with a high offset and low signal amplitude. The offset is deducted by a circuit on the Measured Value PCB. The dynamic range of the A/D converter is, thus, perfectly adapted to the O_2 sensor.

An electronic switch disconnects the O_2 sensor and short-circuits the input of the O_2 measuring circuit (O_2-4 test) thus enabling measurement of the O_2 measuring circuit offset. This offset is corrected by system software.

The O_2 sensor must be calibrated every 24 hours. The cyclic zeroing time of the agent analyzer is not sufficient to do so. If the O_2 sensor needs to be calibrated during operation (for example, because an O_2 INOP alarm has occurred) but the sensor voltage is still within the permissible range, the agent analyzer will switch the O_2 sensor to ambient air and the O_2 sensor will be calibrated. No anesthetic gas values and no CO_2 values will be displayed during the calibration process.

Approximately 3 minutes after each cold start, the O_2 sensor is subjected to an automatic 21% O_2 calibration which may take up to 3 minutes. The calibration factor measured is stored in the RAM of the CIO PCB and used for warm starts. Manual calibration can still be initialized from the control menu.

The agent analyzer is zeroed at least once every hour. The O_2 sensor is checked during zeroing. The value measured should be between 18 and 24% O_2. If not, O_2 INOP will be displayed.

The sidestream O_2 sensor is located behind the cuvette of the anesthetic gas module.

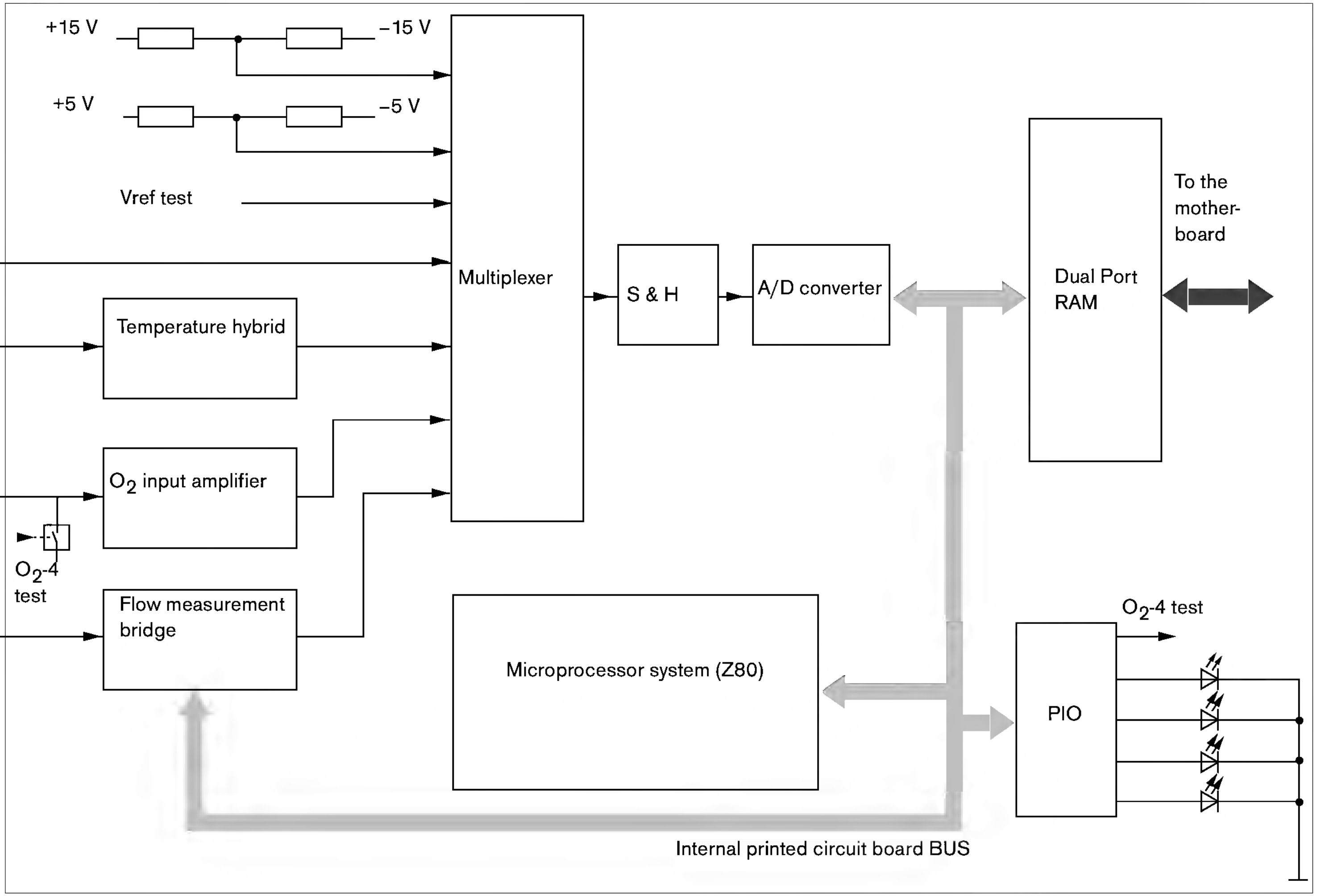


Fig.175: Block diagram of Measured Value PCB

75 Front PCB

The front assembly (consisting of display, keypad, and Front PCB) provides the user interface to Julian.

The Front PCB controls the following subassemblies/components:

- display
- LEDs
- loudspeaker
- keys
- rotary knob

The 68332 microcontroller on the CIO PCB loads the program for the graphics processor into the video RAM and initializes the graphics processor.

The graphics processor controls the display. Video RAM stores data for the display. The video logic and drivers display this data on the display. The video logic and driver modules are designed so that other types of display can be used.

The sound chip generates the audible alarms the volume of which can be altered by the operator. To do this, the sound chip switches through different analog switches thereby changing the resistance (potentiometer principle) and thus the volume. The sound chip monitors the loudspeaker connection and is able to detect a disconnection of the loudspeaker.

The sound chip and the 68332 microcontroller on the CIO PCB scan the rotary knob and the keys. The keys are not multiplexed. The CIO PCB controls the LEDs using the appropriate drivers on the Front PCB.

The CAN interface reads the data from the graphics processor and sends this data to the CAN network. This data is required for the Julian Safety Concept.

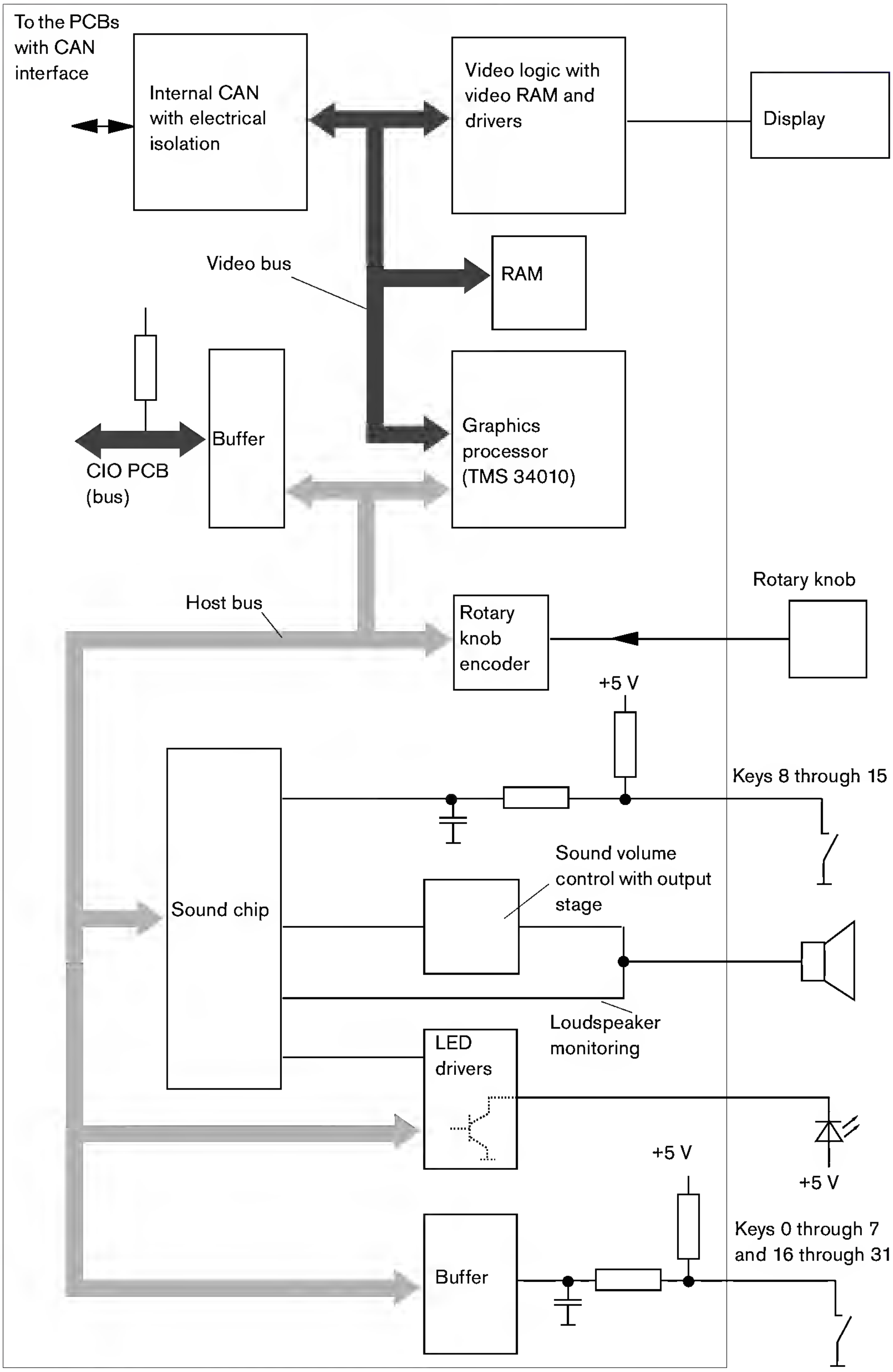


Fig.176: Block diagram of Front PCB

76 Front Adapter PCB

The Front Adapter PCB provides the interface between LEDs, keys, rotary knob, loudspeaker, and Front PCB. Like the motherboard, the Front Adapter PCB provides only connections, except for the power-on delay element which is the only active circuit element on the Front Adapter PCB.

During power-on self test, the power-on delay element applies a +12 V voltage to the display with a specific delay which prevents the display from drawing too much current and putting too much load on the +12 V voltage.

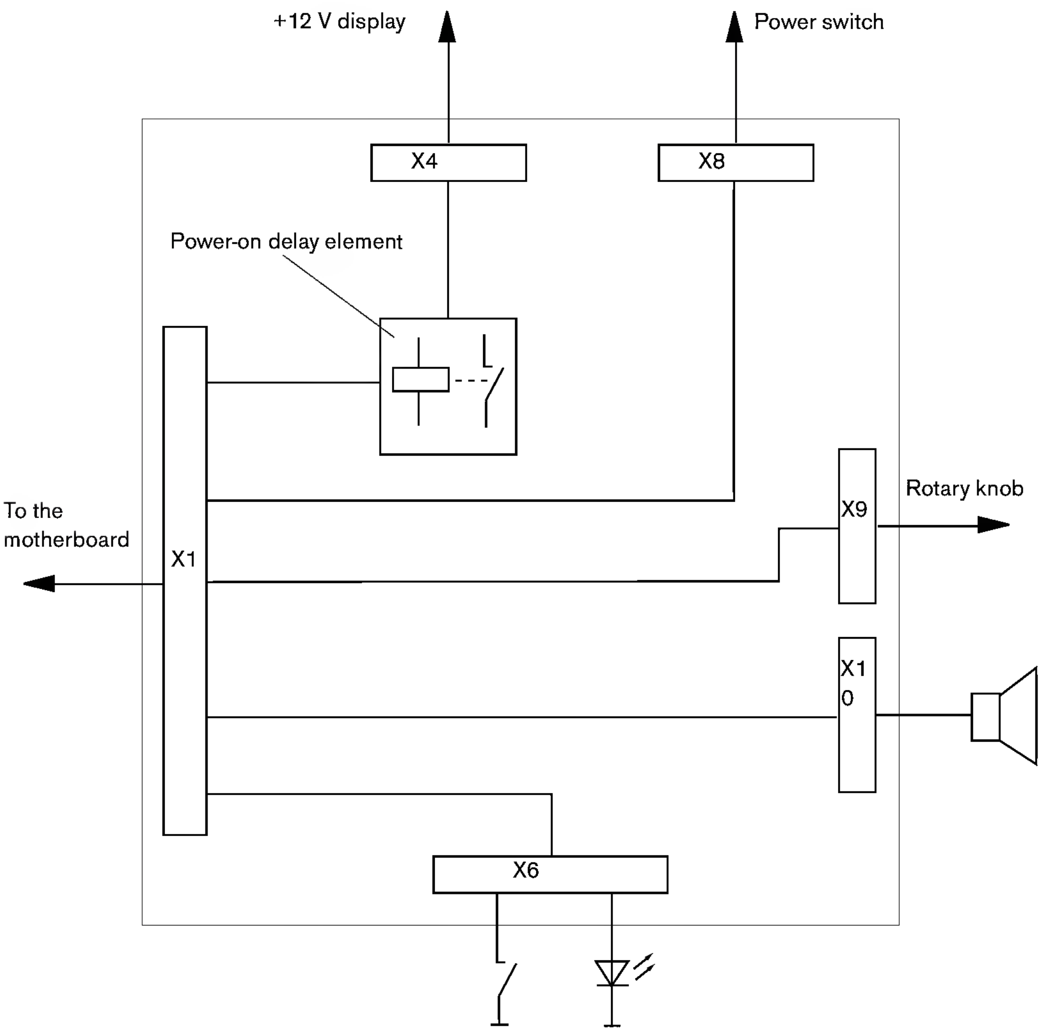


Fig.177: Block diagram of Front Adapter PCB

77 SpO_2 PCB (Optional)

The SpO_2 PCB and the SpO_2 sensor measure the functional O_2 saturation in the blood. The electronics of the SpO_2 PCB is electrically isolated from other sub-assemblies. This isolation is created by optocouplers and a DC/DC converter. A level converter uses the +5V supply to generate supply voltages for the SpO_2 module. The measured value is transmitted to the CIO PCB via an RS232 interface.

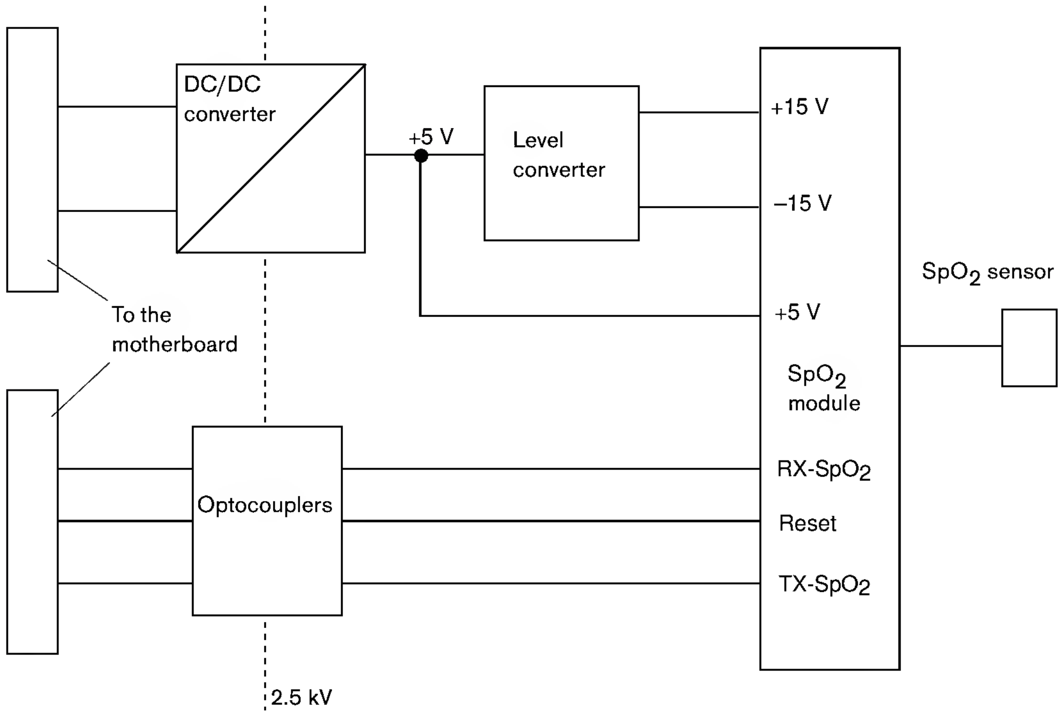


Fig.178: Block diagram of SpO_2 PCB

78 EPI Controller PCB (USA Version)

Julian is connected to the pipeline system via three ISO connections which are located on the rear panel. Pipeline pressures for O_2, N_2O, and AIR range from 2.7 bar to 5.5 bar. These pressures are digitally displayed on the front panel.

An optional high-pressure conversion kit can be connected via two additional ISO connections. This kit consists of two gas cylinders (O_2 and N_2O). The high pressure regulators (200 bar/5 bar for O_2 and 60 bar/5 bar for N_2O) and the check valves are located on the gas cylinders. The gas cylinder pressure is displayed on digital displays. Cylinder pressure sensors are located on the respective pressure regulators.

If, for example, the O_2 pipeline fails, Julian switches to O_2 gas cylinder supply (if available) by means of electrical reversing valves.

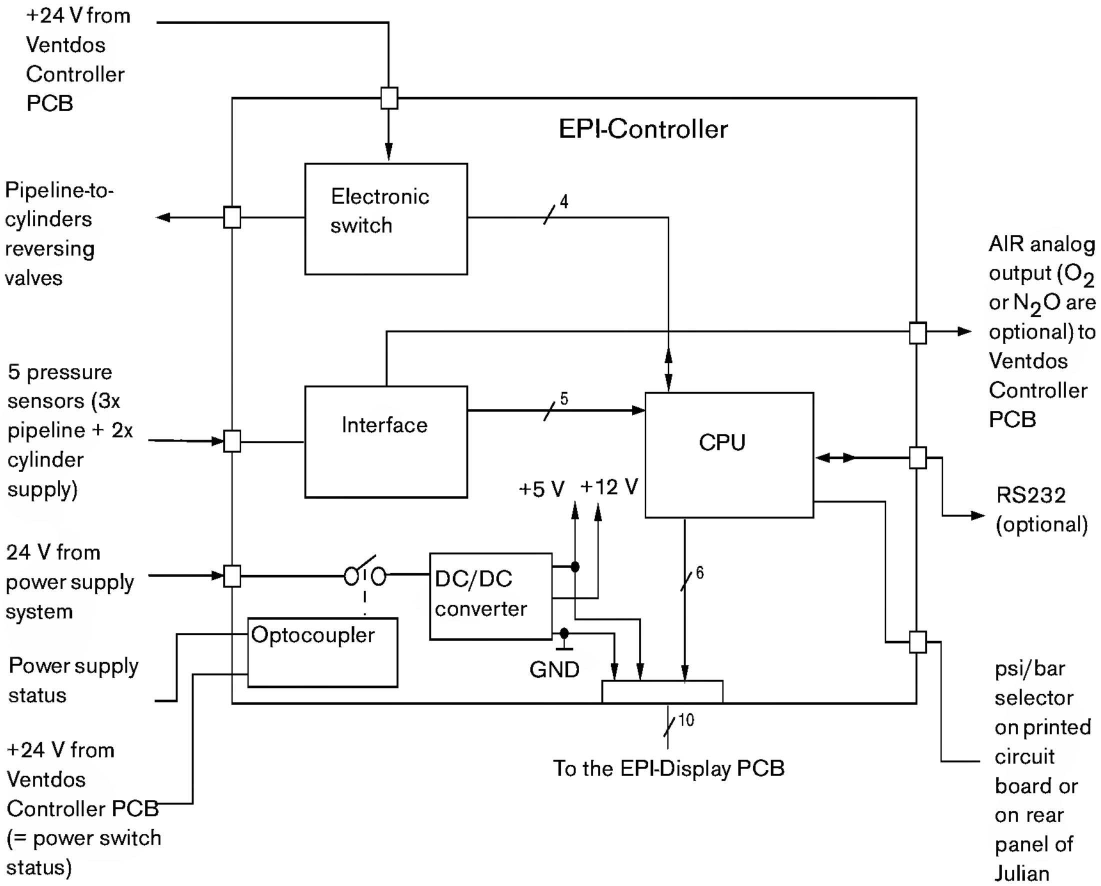


Fig.179: Display and evaluation of pipeline system and cylinder pressure

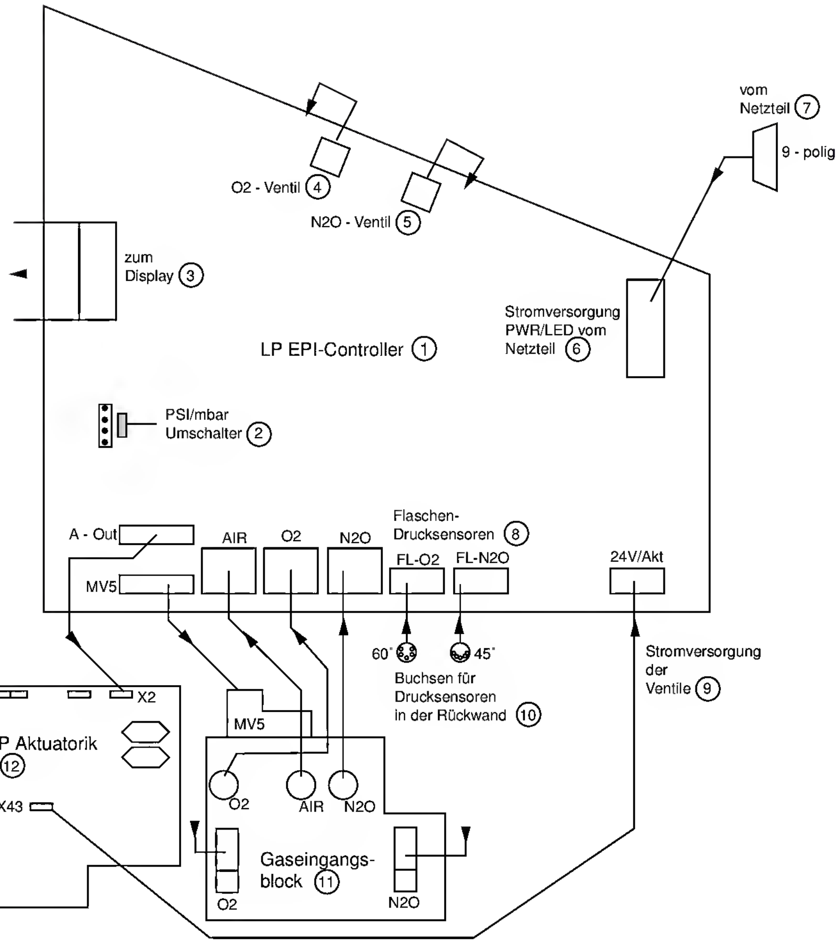


Fig. 180: Interconnection diagram of EPI controller, actuators and gas inlet block

Table 6: Legend

1	EPI Controller PCB	8	Cylinder pressure sensors
2	PSI/mbar selector	9	Power supply to valves
3	To display	10	Pressure-sensor connectors on rear panel
4	O2 valve	11	Gas inlet block
5	N2O valve	12	Actuator PCB
6	Power supply PWR/LED from power supply unit		
7	From power supply unit (9-pin connector)		

78.1 Digital Display Control

The printed circuit board assemblies EPI Controller PCB and EPI Display PCB control the digital displays and evaluate the pressure signals.

Function

The digital displays located on the front panel indicate the pipeline system and gas cylinder pressures. The display range for pipeline system pressures lies between 0 and 9.9 bar (tolerance for the range 2.7 to 5.5 bar is ±2%), the display range for gas cylinder pressures lies between 0 and 190 bar (±4%). A mechanical selector on the rear panel allows the user to switch the pressure unit display from bar to psi. The CPU on the EPI-Controller PCB verifies the position of the switch and processes the pressure signals accordingly.

Pressure values are displayed under the following conditions:

– Julian is turned ON (powered either from AC supply or backup battery)

– Julian is turned OFF, but the power cord is connected to the AC outlet (the CPU on the EPI-Controller PCB recognizes this status via the "Mains Voltage" status line)

Built-in pressure sensors measure the pressure (pipeline system = O_2, AIR, N_2O; gas cylinders = O_2, N_2O). The pressure signals are processed by the EPI-Controller PCB. If the pipeline system pressure decreases below one of the set lower limits, the CPU switches the respective solenoid valve to the gas cylinder supply position and generates an alarm.

The CPU controls the digital display which indicate the pressure values either in bar or psi. The measured values are available as analog or digital (RS232) signals through external interfaces. The digital interface is not used in Julian. The analog voltages are fed to the Ventdos Controller PCB.

Monitoring

The CPU located on the EPI-Controller PCB monitors the pipeline system and gas cylinder pressures. If a pressure decreases below a specified value, the digital displays start to flash and an audible alarm sounds for 60 s. This alarm is generated under the following conditions:

O2, N2O:

– If, after the last power-on, the pipeline system pressure has decreased below 2.7 bar and there is no gas cylinder pressure available (for example, gas cylinders are closed), or if the gas cylinder pressure is below 10 bar and the pipeline system pressure is below 2.7 bar.

AIR:

– If pipeline system pressure decreases below 2.7 bar.

The alarm will be deactivated as soon as the pressure is within specified limits or when Julian is switched off.

78.1.1 EPI Display PCB

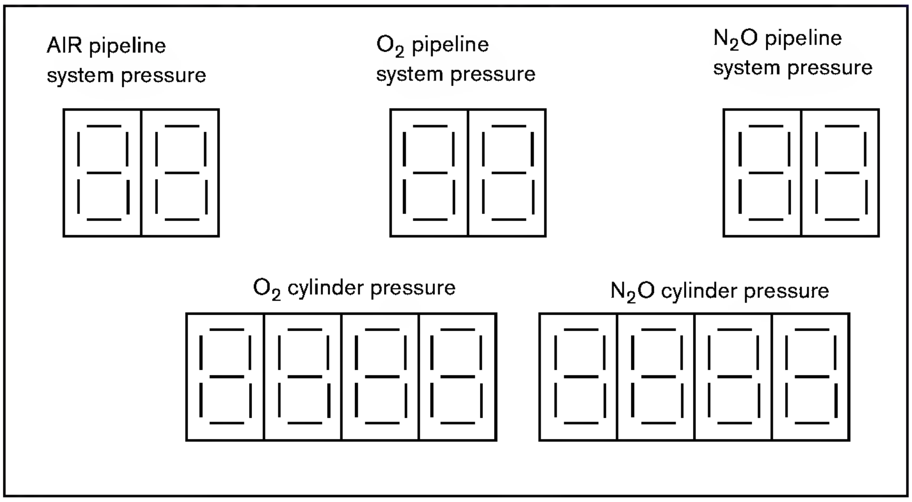


Fig. 181: Digital displays on the EPI Display PCB

Agent Analyzer (IRIA)

Contents:

79 Agent Analyzer (IRIA)

IRIA measures the anesthetic agents in the breathing system (N_2O, Halothane, Enflurane, Isoflurane, Desflurane, Sevoflurane) and the CO_2 concentration in the respiratory gas. The measured values are transmitted to Julian's electronics (CIO PCB/data management) via an RS232 interface.

IRIA is located in the monitor housing of Julian. The water trap and the O_2 sensor are located in the IRIA. There are two different types of water traps available: the Dräger water trap and the Ohmeda water trap.

The water traps are used to remove the water contained in the sample gas. This is done by a Goretex diaphragm.

79.1 Dräger Water Trap

In the Dräger water trap, the 2 Goretex diaphragms are permanently attached to the water container. The water trap can be drained as many times as necessary within one month using disposable syringes. To do so, the water trap must be removed from its mount. The water trap should be disposed of after one month. The 2 Goretex diaphragms of the Dräger water trap prevent water from entering the path to the cuvette and the bypass branch.

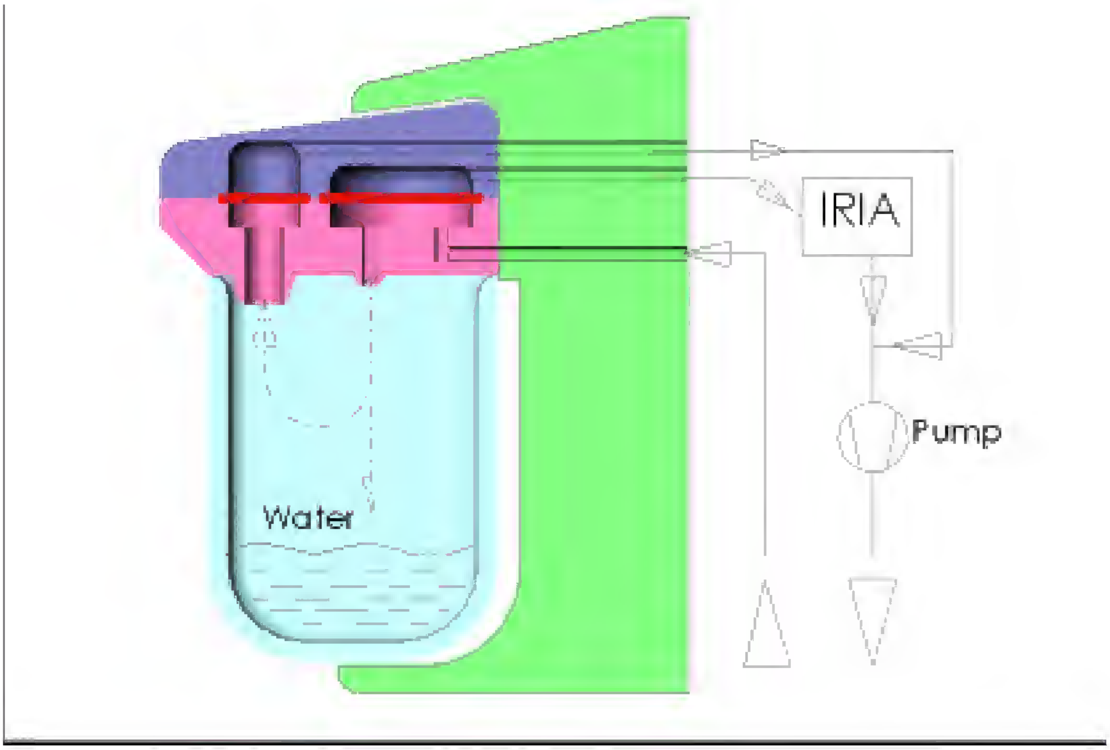


Fig.182: Functional principle of the Dräger water trap

If the water in the water container reaches the diaphragms, the latter will be sealed off and the message "CO2 line" is displayed. The Dräger water trap has no electronic filling level detector. The resistance ratios of the two Goretex diaphragms are such that splitting up into sampling branch and bypass branch can be achieved without using an additional restrictor.

79.2 Ohmeda Water Trap

The water trap removes condensation from the sample gas. A Goretex diaphragm integrated in the water separator removes condensation from the drawn respiratory gas. The water separator directs the liquid into a container which must be emptied as soon as it reaches a certain filling level. The filling level of the container is detected automatically and displayed on the monitor.

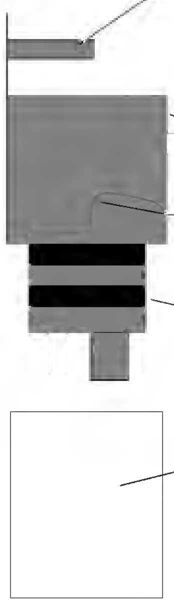


Fig.183: Water trap components

79.2.1 Water Separator

The water separator is the main component of the water trap. Sample gas (for example, 200 mL/min) is drawn by the agent analyzer pump and directed to the water trap's luer lock connection. The gas reaches connection 1 and flows into the filter element. A major portion (180 mL/min) of the gas is removed through the Goretex diaphragm at connection 2. The Goretex diaphragm filters out the water contained in the gas. This portion of the gas travels to the cuvette where it is measured.

The remaining portion of the gas (20 mL/min) is used to transport the removed water into a container. This container must be emptied at regular intervals in order to prevent water and contamination from getting into the bypass branch (20 mL) and obstructing hoses and restrictors.

A functional water separator creates a decrease in pressure of 25 to 70 mbar in the tubing system. A new water separator creates a decrease in pressure of about 20 mbar. A spent water separator creates a higher decrease in pressure and a lower suction rate. In this case, the message "CO2 line!?" is displayed. The water separator must then be replaced with a

new one. At a flow rate of 200 mL/min, the decrease in pressure in the total tubing system is 100 mbar. If pressure decreases by more than 200 mbar below ambient pressure, or if the 200 mL/min flow rate decreases below 170 mL/min, the message "CO2 line!?" will be displayed.

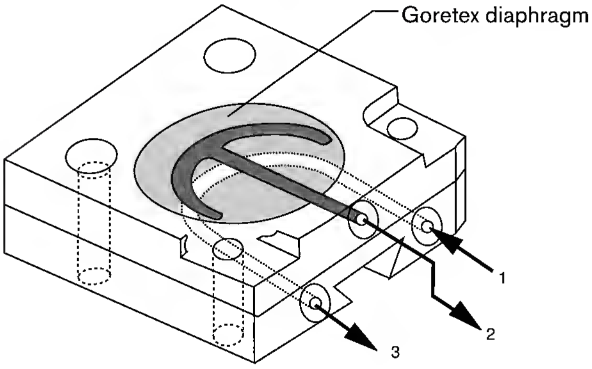


Fig.184: Water trap filter

1. 200 mL sample gas
2. 180 mL sample gas
3. 20 mL transport gas

79.2.2 Water Level Detector PCB

The Water Level Detector PCB is located on the IRIA module. If the Water Level Detector PCB detects a "full" water trap, it switches off the agent analyzer pump in order to prevent the system from drawing in water. When the water trap is full, the monitor displays the message "Water trap!?".

79.3 Optical Measuring System

The optical measuring system is comprised of the agent analyzer and associated electronics. A pump for transporting the sample gas and a reversing valve for zeroing are also required. All components necessary for gas measurement are mounted on a bracket which allows the entire module to be easily replaced in the field.

Other components used are:

- solenoid valves
- Processor PCB
- cuvette
- Pump PCB
- pump

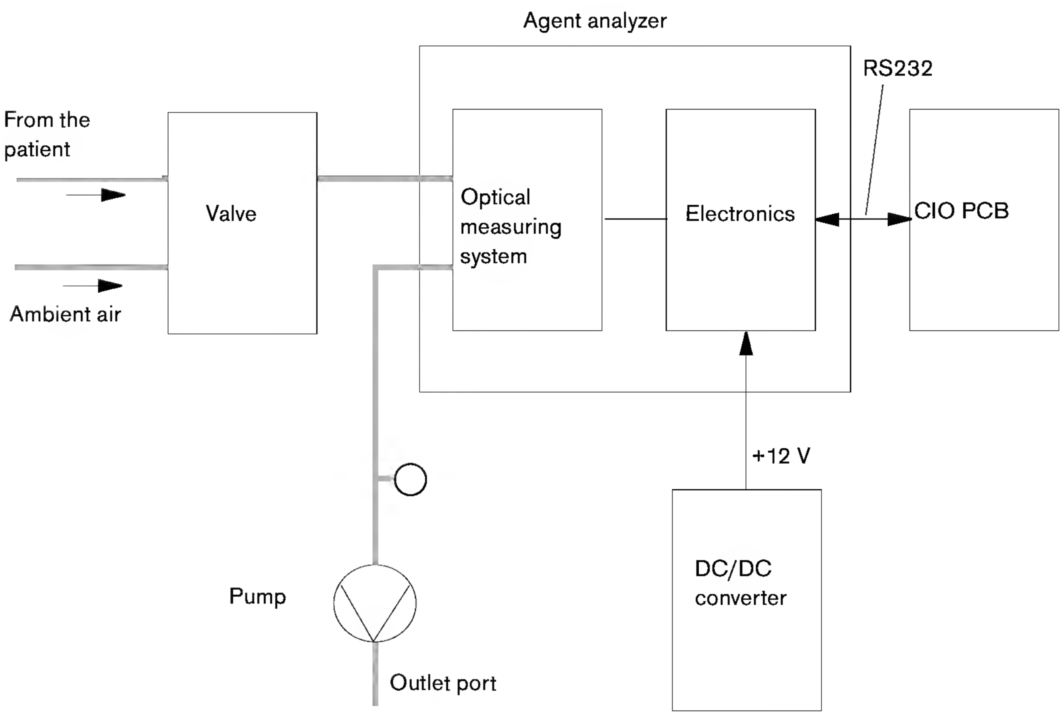
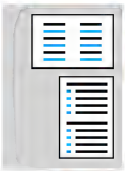


Fig.185: Block diagram of the IRIA module



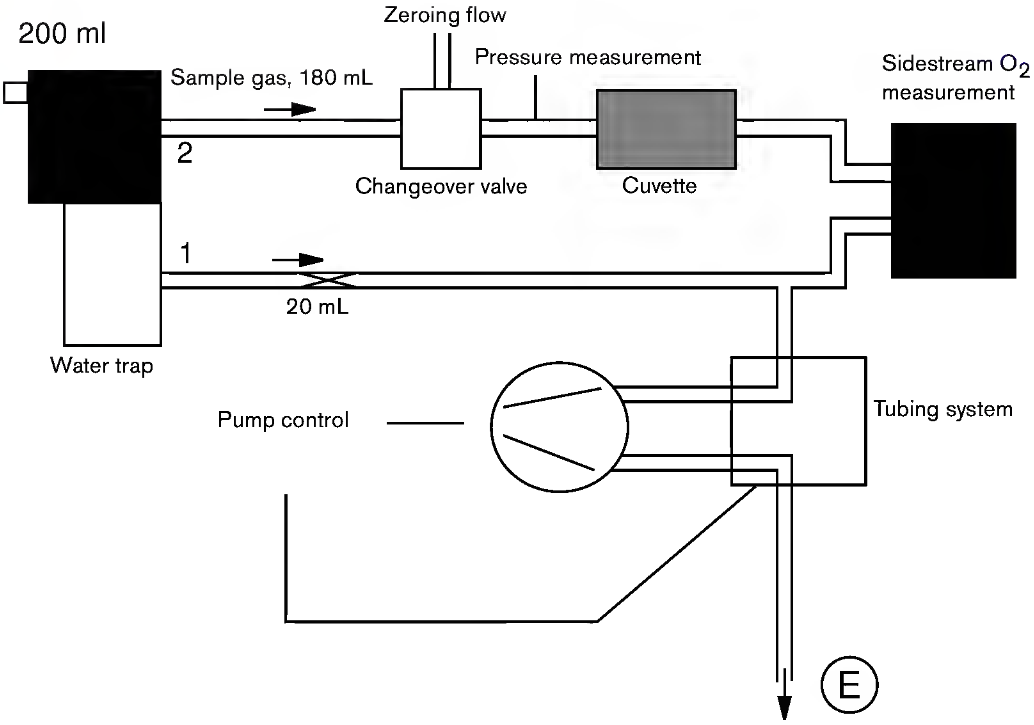


Fig.186: Connection diagram of the IRIA module

79.3.1 Measuring Principle

The measuring principle of IRIA is based on the infrared absorption technique. Infrared radiation emitted by a hot wire (light source) passes through a filter wheel (a collection of 8 filters) which absorbs a major part of the infrared radiation. Only wavelengths in the shorter and medium range of the infrared spectrum are not filtered. These wavelengths are used to measure CO_2/N_2O (NIR approx. 3 µm) and anesthetic gases (MIR approx. 8 µm).

The filter wheel has the following filters:

- 3 filters for anesthetic gases
- 2 reference filters for NIR and MIR
- 1 zeroing filter
- 1 filter for CO_2 and 1 for N_2O

A cuvette (sample cell) is located in the beam path behind the filter wheel. The gas sample reduces the infrared radiation according to its composition. The respective signals are directed to the detector and transmitted to the evaluation electronics.

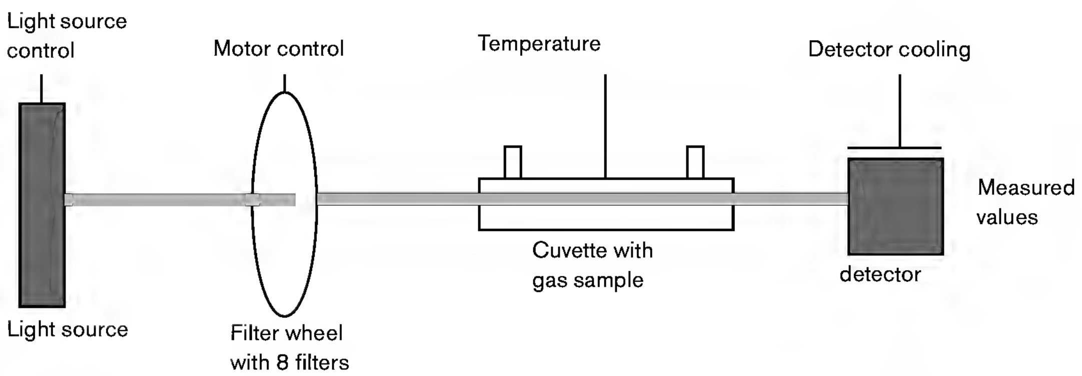


Fig.187: Measurement principle of the agent analyzer

The electronics use the signals to generate values for CO_2, N_2O, and the anesthetic gases (Halothane, Enflurane, Isoflurane, Desflurane and Sevoflurane). The values for each breath are transmitted to the CIO PCB through the RS232 interface. In order to ensure an accurate CO_2 measurement, it is necessary to carry out O_2 correction. This is done by transferring O_2 values from the monitor to the agent analyzer. The required voltage supply is +12 V.

79.4 Hardware Configuration

The IRIA module is mounted on a bracket. It is ready for use as soon as the electrical and pneumatic connections are made. The IRIA module needs a +12 V voltage supply and a serial interface. Pneumatic connections include the sample gas connection and the sample gas return line.

79.5 Assemblies

The IRIA module consists of the following replaceable assemblies:

- sensor head with cuvette
- Flow PCB
- pump
- changeover valves
- Processor PCB

79.5.1 Sensor Head

The sensor head contains the optical components (light source, detector, lenses, filter wheel), the motor, the cuvette, the heating foils, the pressure sensor (compensation for pressure fluctuations), the Pyro PCB (first amplifier stage for the detector), the Preamplifier PCB (15 measuring channels, e.g., pressure, temperature, pyro) and the Control PCB (motor control, temperature control, and light source control).

79.5.2 Optical System

The light source (pellistor) is heated to a temperature of up to 800 °C. It radiates a wide band of light and is monitored by a power controller (3 V, 1A). Radiation is focused by a germanium lens located on the filter wheel. The filter wheel is located in the path of the beam. Wavelengths which pass through the optical filters are directed to the cuvette. After passing the cuvette, infrared radiation is focused by another lens which is located on the detector.

79.5.3 Motor

The system uses a DC motor rotating at 3300 rpm. In order to keep the speed constant, the motor is controlled by the processor using the pulse-width modulation (PWM) technique. The filter wheel, which is counterbalanced with the motor, is mounted on the motor shaft. A light-barrier monitors motor speed.

79.5.4 Heating

The IRIA module has two heating circuits with heating foils. The large heating circuit is used to bring the IRIA module up to operating temperature quickly. The small heating circuit is used to control the actual temperature (PWM). The operating temperature of 55 °C is monitored with a NTC thermistor.

79.5.5 Pressure Sensor

The pressure sensor compensates for pressure fluctuations in order prevent false measurements. The pressure sensor is temperature-sensitive, therefore it is located in the sensor head.

79.5.6 Filters

The filters are made of germanium covered with up to 100 layers.

79.5.7 Flow PCB

The Flow PCB controls and regulates the pump (zeroing, flushing, sampling) and contains a pressure sensor with a restrictor for flow control.

79.5.8 Processor PCB

The Processor PCB provides the monitor interface, calculates concentration and checks signals from the sensor head.

79.5.9 Pump

The pump is used to transport the sample gas.

79.5.10 Valves

For monitoring reasons, the IRIA module has two valves used to switch between zeroing and the sampling mode.

Power Supply Unit and DC/DC Converter

Contents:

80 Power Supply Unit and DC/DC Converter

Julian's power supply system consists of two sub-assemblies, the power supply unit and the DC/DC converter. These two sub-assemblies are connected to one power line (voltage supply to the DC/DC converter) and one data line (status signals and CAN).

80.1 Power Supply Unit 8601619

The power supply unit input voltage ranges from 90 VAC to 265 VAC. When Julian is powered from the AC outlet, the output voltage lies between +29 VDC and +30.5 VDC. When Julian is powered from the backup battery system, the output voltage lies between +18.5 VDC and +29 VDC

The power supply unit includes a backup battery system (uninterruptible power supply). Two batteries will provide power should the AC outlet supply fail. In this case, Julian can be used for approximately 30 minutes provided the batteries are fully charged. The convenience receptacles are not active when Julian is not powered from an AC outlet.

The direction of current for the batteries is recognized and made available to the CIO PCB through the CAN interface. The CIO PCB detects whether a charging current (powered from an AC outlet) or discharging current (powered from backup battery system) is present.

Power supply units with internal batteries are provided with a miniature circuit breaker in the positive line to the internal battery pack. This miniature circuit breaker interrupts this line should the current flow be too high (for example, short circuit at the terminals). The miniature circuit breaker can be reset via a hole in the power supply unit housing. Power supply units (8601695) with external batteries are provided with a 25 A fuse in the positive line to the battery pack.

When the power cord is connected to an AC outlet and the power supply unit power switch is set to ON, Julian recharges the batteries. The internal fan's speed varies with the charging current; that is, the higher the charging current, the faster the internal fan turns. When Julian is connected to an AC outlet, an LED on the front panel will flash. This LED is controlled directly by the power supply unit.

The external fan starts turning as soon as Julian is switched on.
Power supply units shipped until June 1998 have a built-in 24 V external fan. Two of the four convenience receptacles are switched.
Power supply units shipped as of June 1998 have a built-in 12 V external fan. Julian is equipped with 2 or 3 convenience receptacles (depending on the country version) which are located on the rear panel. By factory default setting, these convenience receptacles are connected to the non-switched sockets of the power supply unit (see Fig. 190: "Diagram of power supply unit 8601619 (as of June 1998) and DC/DC converter"). A separate wiring is not possible.

The output voltage at the power supply unit (24 V) is always present even when the device's power cord is disconnected from the AC outlet (in this case Julian is powered from the backup battery system) but the device cannot be switched on if the power cord is disconnected.

An external battery (24 V output voltage) can be connected to the power supply unit. This allows the user to switch on Julian even when the power cord is disconnected from the AC outlet. The external battery is not recharged by Julian's battery charging system.

80.2 Power Supply Unit 8601765 with External Batteries 8601764

Differences from power supply unit 8601619

- As of version "Ver04" (available approx. March 1999) batteries will not be located in the power supply unit housing any more.
- The miniature circuit breaker in the batteries' plus line has been omitted. A 24 A fuse has been integrated in the plus line to the batteries instead.

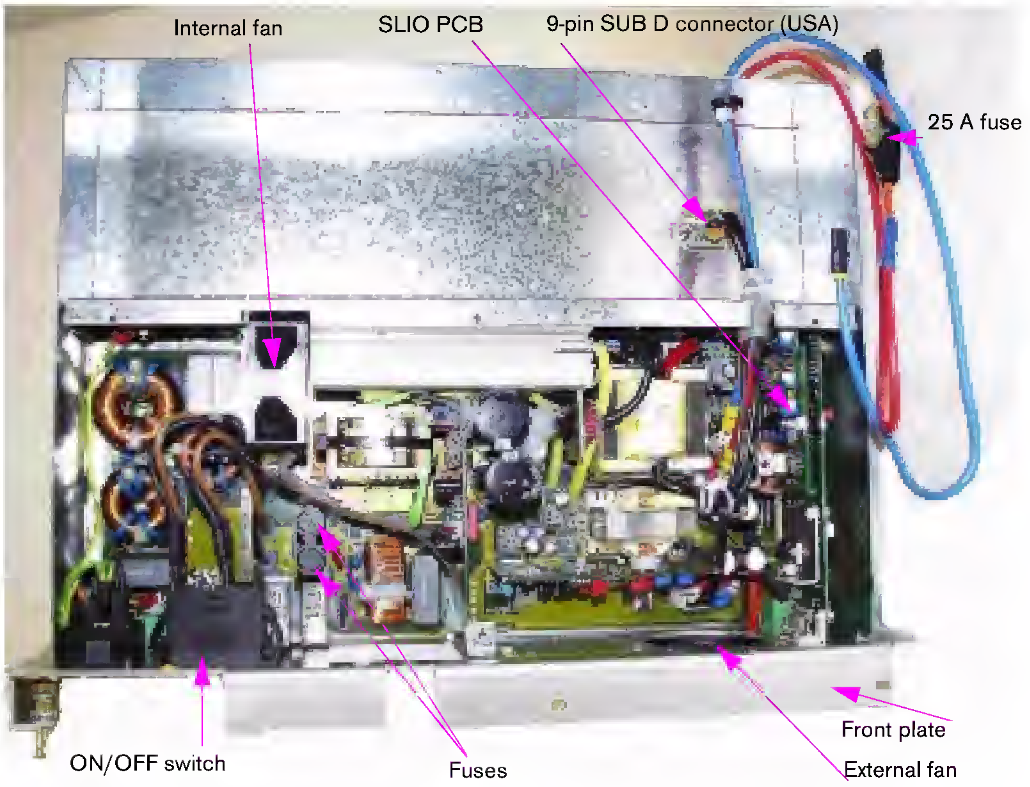


Fig.188: Inside view of power supply unit 8601765 as of version "Ver04"

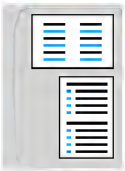
- As of version "Ver05" (available approx. mid-1999), the power supply unit automatically checks the battery and can generate a status bit "Battery defective". This signal is not generated up to version "Ver04" of the power supply unit. Therefore, as of software version "2.02" of Julian, the battery detection function must be activated for power

supply units as of "Ver05" or deactivated for power supply units below "Ver05" (this can be done under Service Mode/Service Mode 2/additional). A wrong battery detection setting can lead to error messages during the self-test.

80.2.1 Fuses/Circuit Breakers

The power supply system is equipped with 4 fuses/circuit breakers.

- Two fuses are located directly behind the power switch of the power supply unit (10 A).
- A thermomagnetic release located in the power switch on the power supply unit is activated when the current is too high (for example, if the input voltage is too high). After cooling down, the thermomagnetic release can be reactivated by switching off and on.
- Applies to power supply unit 8601619 only:
  A miniature circuit breaker is located in the plus line of the batteries. The miniature circuit breaker can be reset by the operator through a hole on the power supply unit housing.
- Applies to power supply unit 8601764/65 or later
  A 25 A fuse is located in the plus line of the batteries.
- An electronic thermostat disconnects the power supply unit should the temperature increase above a defined level. In this case, Julian will be powered from the backup battery system. After cooling down, the electronic thermostat can be reset by the operator by switching the device off and on again.
- Each of the convenience receptacles on the rear panel is equipped with 2 fuses of different size or with one miniature circuit breaker (depending on the country-specific version of Julian).



80.3 DC/DC Converter

The DC/DC converter generates supply voltages for the monitor and the pneumatics using positive voltage (U1) from the power supply unit. One DC/DC converter each is available for monitor and pneumatic voltages.

When the device is switched off, the DC/DC converter electronics interrupt the power supply and send a status signal to the Ventdos PCB. The Ventdos PCB delays the shut-down procedure in order to set certain valves to their preferred position (for example, valve V28).

80.3.1 Output Voltages of the DC/DC Converter

Monitor:	Pneumatics:
+5 V	+5 V
+12 V	±15 V
±15 V	+24 V
+24 V (provided for future extensions)	

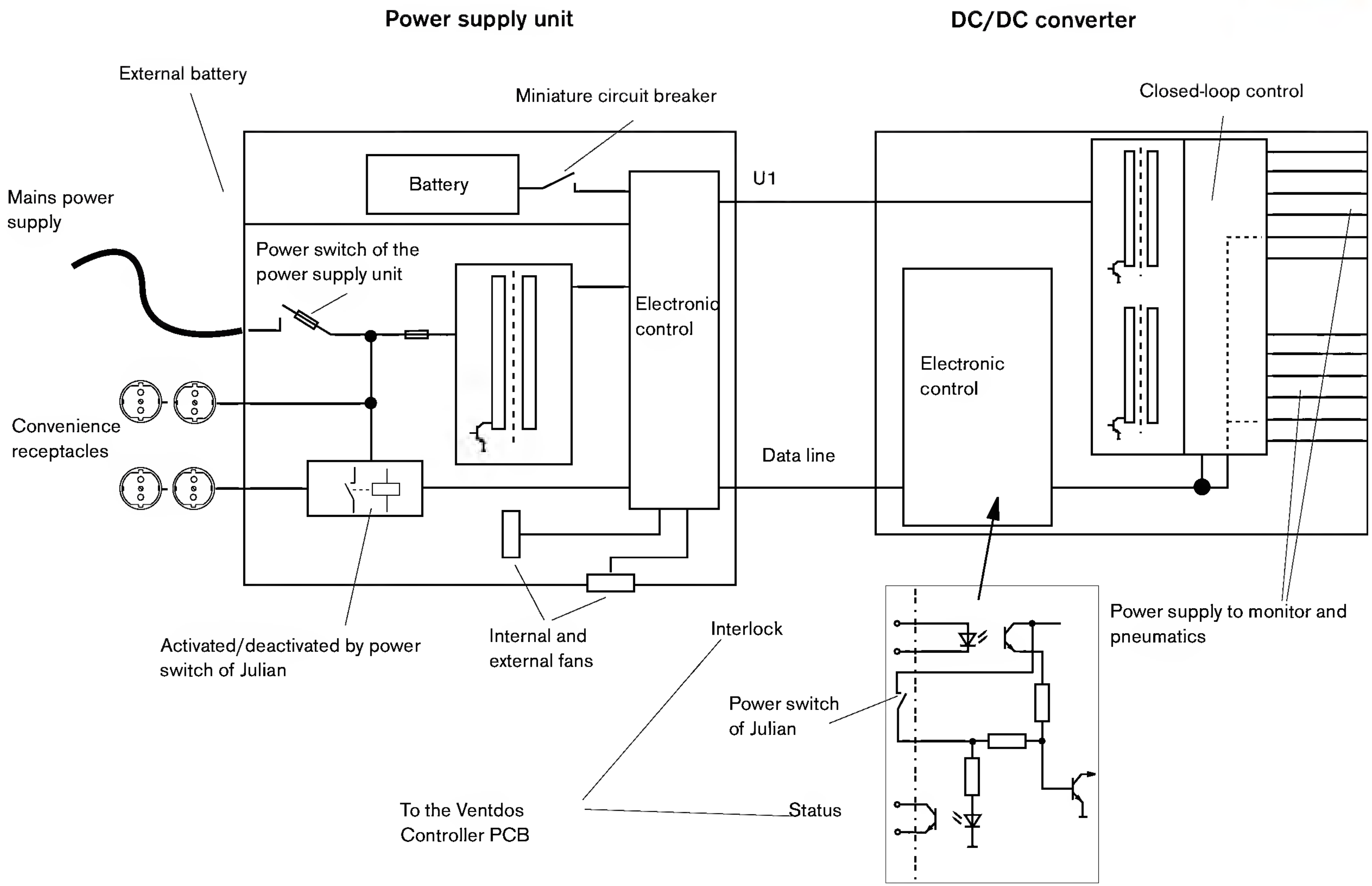
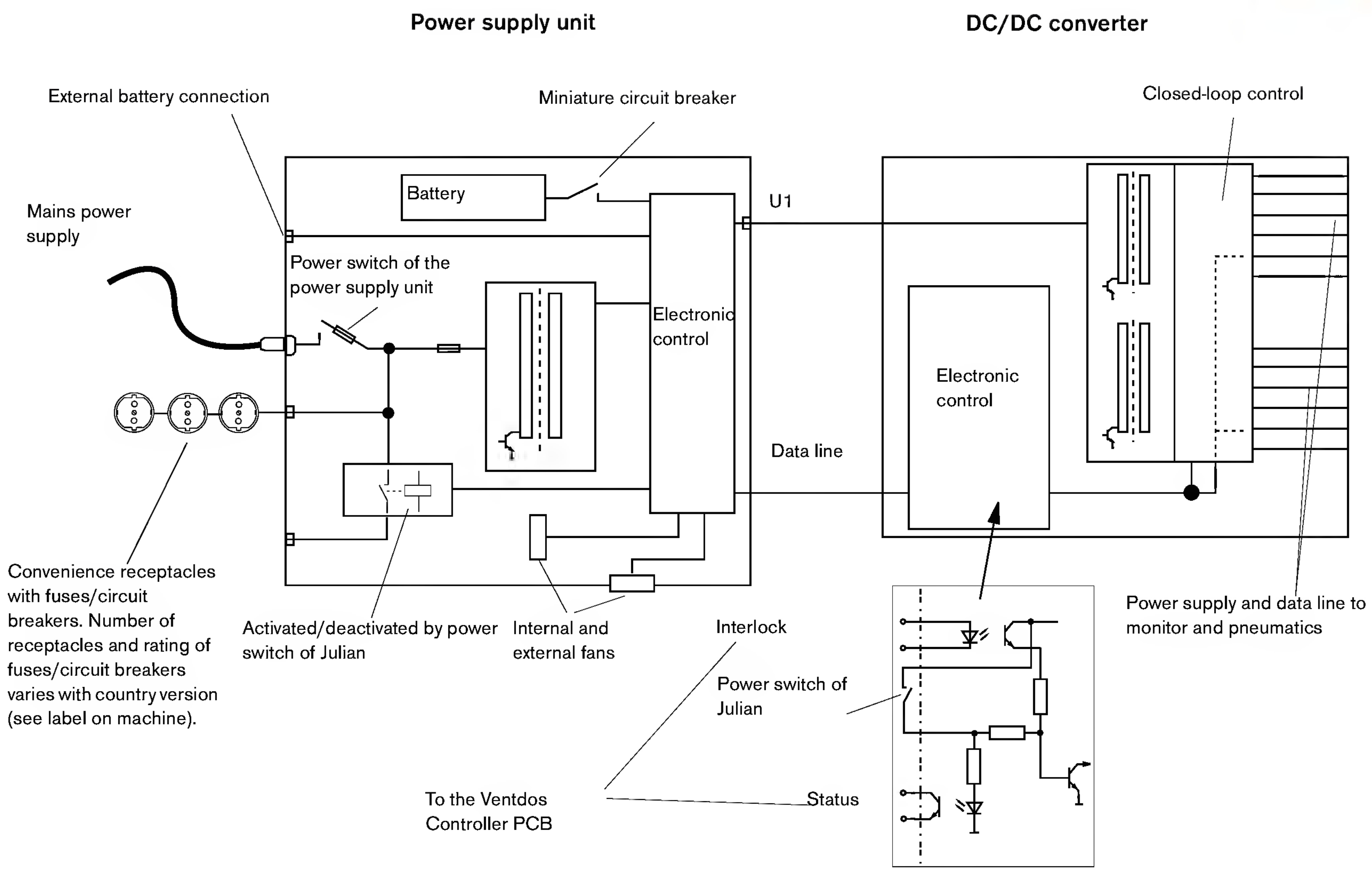


Fig. 189: Diagram of power supply unit 8601619 (until June 1998) and DC/DC converter

Fig.190: Diagram of power supply unit 8601619 (as of June 1998) and DC/DC converter



Dräger Medizintechnik

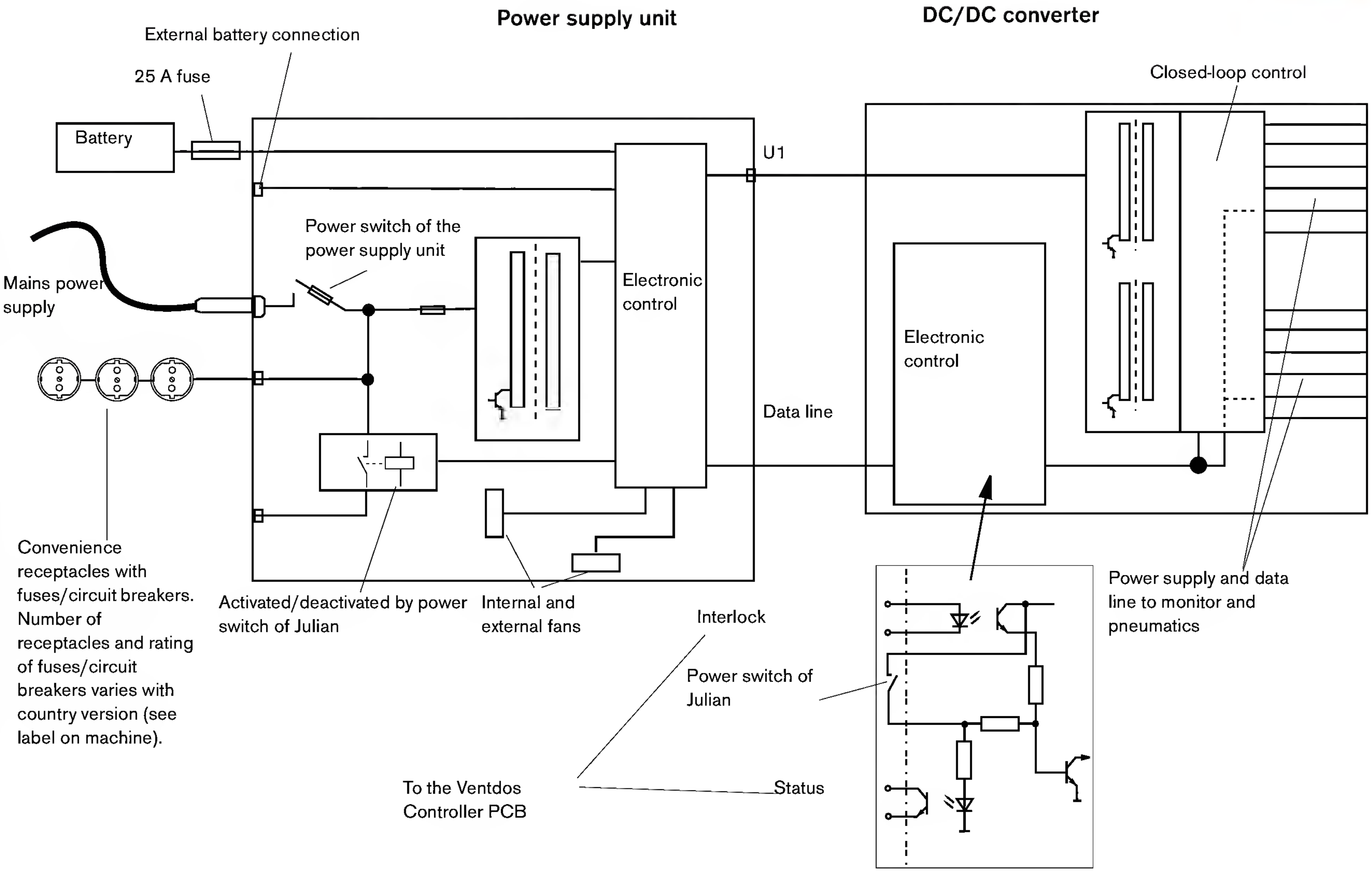


Fig.191: Power supply unit 8601765, external batteries 8601764, DC/DC converter

Printer

81 Connecting the Printer

81.1 Required Items

Besides the Julian you will need the following 3 items:

– Communication cable,
– Serial-to-parallel (S-P) converter
– Printer

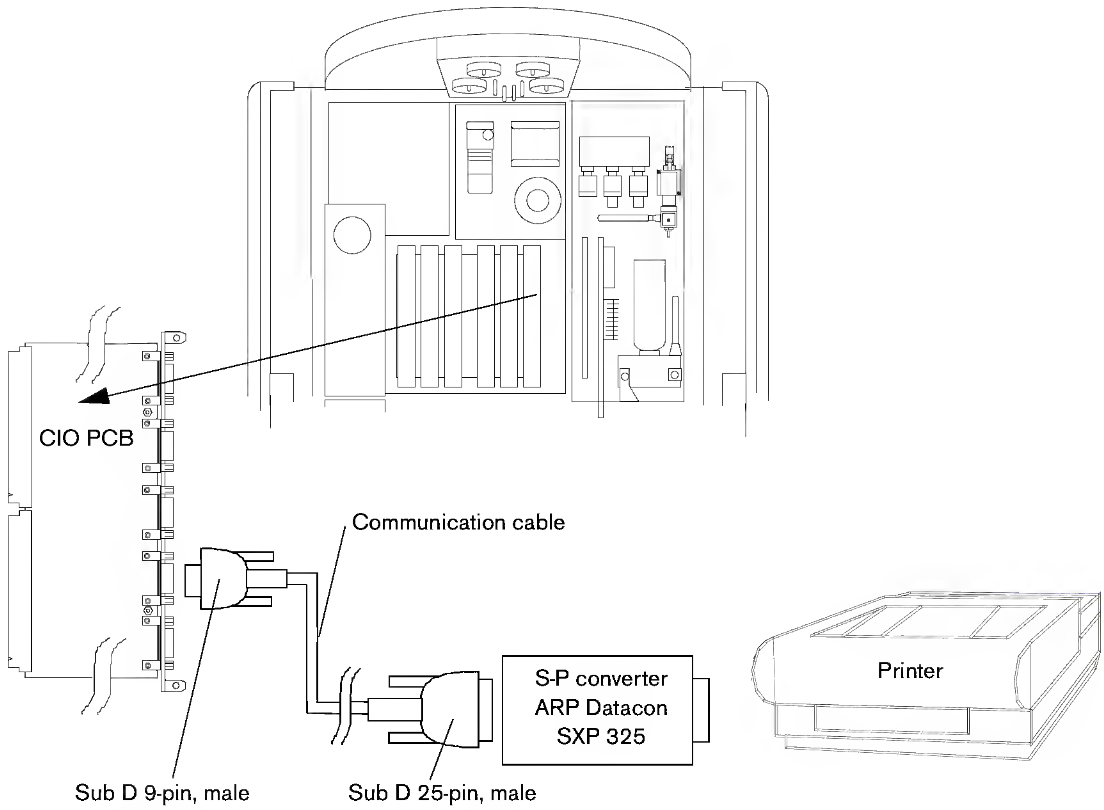


Fig.192: Interconnection diagram for Julian connected to printer

81.1.1 Through Connection of Communication Cable

Table 7: Through Connection of Communication Cable

	Julian Sub D, 9-pin (male)	S-P converter Sub D, 25-pin (male)
Pin layout	2	2
	3	3
	5	7

81.1.2 Serial-to-Parallel Converter

Use the serial-to-parallel converter from the company ARP Datacon (sub D, 25-pin (female) on Centronics with buffer).

Order from:

– ARP Datacon GmbH; Waldstr. 23; 63128 Dietzbach; Germany

– Designation: SXP 325

– Order no.: 102353-W

81.1.3 Printer

If you use the above mentioned serial-to-parallel converter, you should be able to connect and run any conventional printer with Centronics interface.

81.2 Adjusting Julian and S-P Converter

- While in the standby mode, set Julian to the following default values (see Table 8: Interface Setup).

Table 8: Interface Setup

Baud rate	9600
Parity	even
Data bits	8
Stop bits	1

- Set the S-P converter to the same values. To do so, use the respective binary code (see Table 9: S-P converter binary code).

Table 9: S-P converter binary code

Bit	1	2	3	4	5	6	7	8
Position	ON	OFF	ON	X	OFF	OFF	OFF	OFF

81.3 Connecting Julian to Printer

- Interconnect the individual components as shown in the following figure:

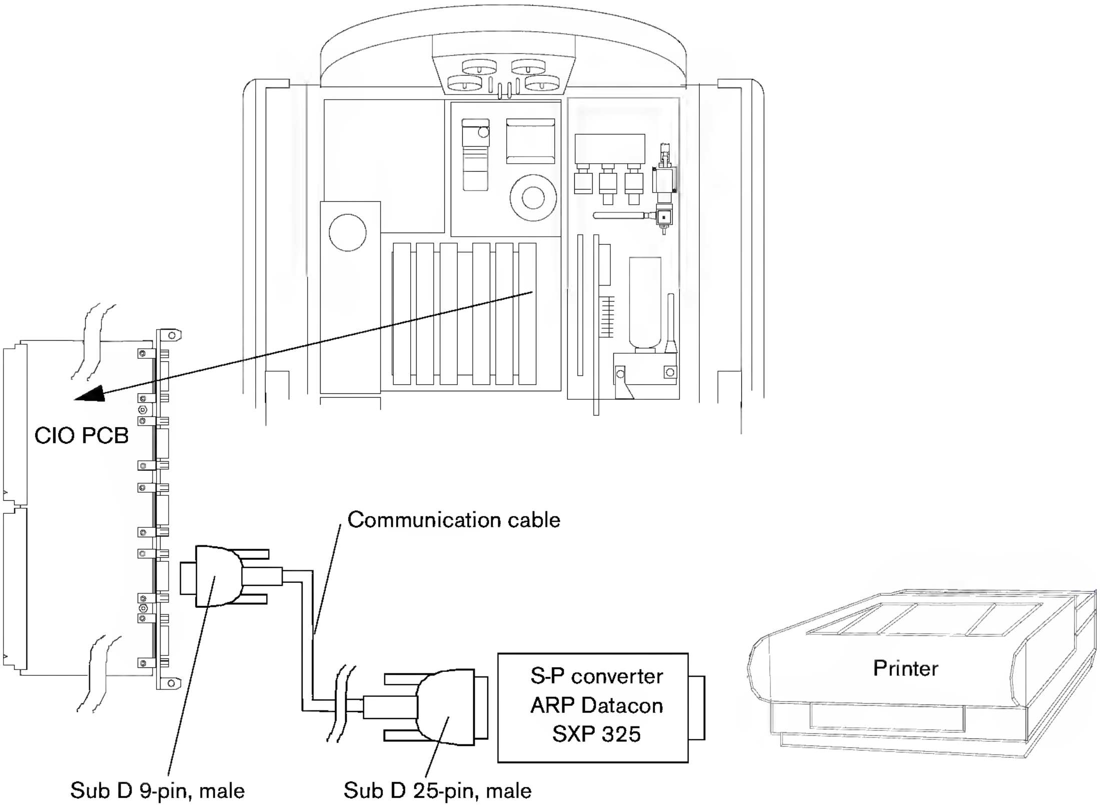


Fig.193: Interconnection diagram for Julian connected to printer

List of Conversions

82 List of Conversions

83 Converting Standby LED to Power-ON LED

83.1 Functional Description

On units with DC converter serial numbers lower than 97392011, the green LED on the left next to the plug symbol on the Julian front panel indicates that Julian is in the standby position.

Units with a DC converter serial number of 97392011 and above feature a design modification introduced by the DC converter manufacturer, whereby the green LED on the left next to the plug symbol on the Julian front panel indicates that mains voltage is being applied.

These instructions describe how to convert a standby LED to a power-ON LED.

83.2 Conversion Instructions

- Switch off Julian.
- Disconnect Julian power plug from AC outlet.

Hazardous voltage! Disconnect power plug from AC outlet before opening unit.

- Unscrew back wall.

A short circuit in the connecting cable (power supply unit to DC/DC converter) will result in sparking and cause destruction of power supply unit and rechargeable batteries. Voltage is still present even with power plug pulled out of AC outlet. Always disconnect connecting cable from power supply unit first.

- Disconnect connecting cable from power supply unit and DC/DC converter.
- Remove DC converter.

Electrostatic discharge can damage electrostatic sensitive devices. Use a static-dissipative mat and a wrist strap when handling electrostatic sensitive devices.

- Remove DC converter cover.

- Remove fastening screws from DC converter front panel to allow removal of DC converter mainboard.
- Remove mainboard fastening screws.
- Place mainboard with component side facing downwards on anti-static mat.
- Disconnect conductor tracks 1 and 2 at marked locations as shown in Figure "Conductor track side of DC converter mainboard".
- Use Teflon stranded wire to make wire link between marked soldering eyelets as shown in figure.
- Jumper gap 1 using diode 1N4148 as shown in Figure "Conductor track side of DC converter mainboard" (solder anode to center pin of outer pin row).

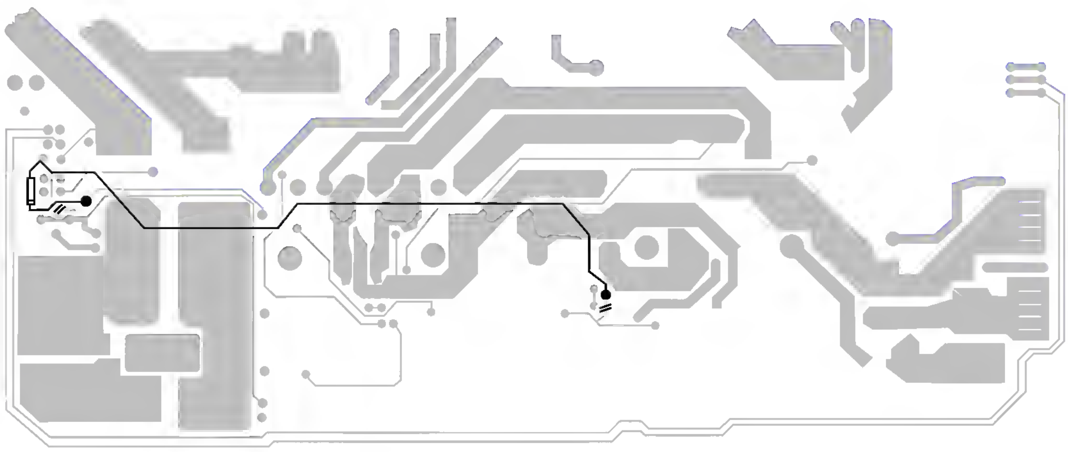


Fig.194: Conductor track side of DC converter mainboard

- Install DC converter mainboard using reverse method of that used for removal.
- Fit DC converter in Julian.
- Screw on back wall of Julian.

83.3 Final Tests

- Perform safety tests according to Julian Test Certificate.
- Connect Julian to pipeline system and AC outlet (power-ON LED should come on).
- Switch on Julian and perform full self test (power-ON LED should remain on).
- As soon as Julian is in standby position, disconnect power plug from AC outlet (power-ON LED should go out, battery symbol in top right corner of screen should start to flash after a few seconds).
- Connect Julian power plug to AC outlet (power-ON LED should come on, battery symbol in top right corner of screen should disappear after a few seconds).
- Switch off Julian (power-ON LED should remain on).
- Disconnect power plug from AC outlet (power-ON LED should go out).
- Switch on Julian (power-ON LED should remain off, Julian should not start self-test, buzzer should sound).
- Switch off Julian and connect power plug to AC outlet.

84 Converting Power Supply Unit, Type 8601619, into Power Supply Unit, Type 8601765

84.1 Description

These conversion instructions describe how to convert from the old type of power supply unit (8601619) to the new type (8601765)

The new power supply unit has no built-in batteries. The batteries (8601764, set of 2) are now located on a separate mount on Julian’s housing. The mains cable is connected to the power supply unit with an inlet connector for non-heating devices.

Conversion of power supply unit (8601619) from internal batteries to external batteries is described in the conversion instructions "External battery pack ".

84.2 Conversion Procedure

Tools and material required:

1x drill bit (4.2 mm)
2x Phillips screws (M4x12, DIN 7985-A2, 1341790)
(ceiling-mounted unit, cap screw M4x30, 1328816)
2x nuts (M4, DIN 985-A4,1336002)
2x washers (4.3 DIN 9021-A4, 1331914)
2x cable ties (8300358)

- Switch Julian OFF.

Hazardous voltage.
Touching live parts may cause severe injury or death.
Disconnect power cord from AC outlet before opening device.

Electrostatic discharge may damage electrostatic sensitive devices.
Use a static-dissipative mat and a wrist strap when handling when handling electrostatic sensitive devices.

- Remove the rear panel.
- First remove the cable connection between the power supply unit and the DC/DC converter at the power supply unit.
- Applies to version "Ver02" or earlier:
  Remove the power cable at the power supply unit.

- Applies to version "Ver02" or earlier:
  Mount the provided inlet connector for non-heating devices onto the power cable.
  Replace the cable connector sleeves.
- Remove the old power supply unit and mount the new one.

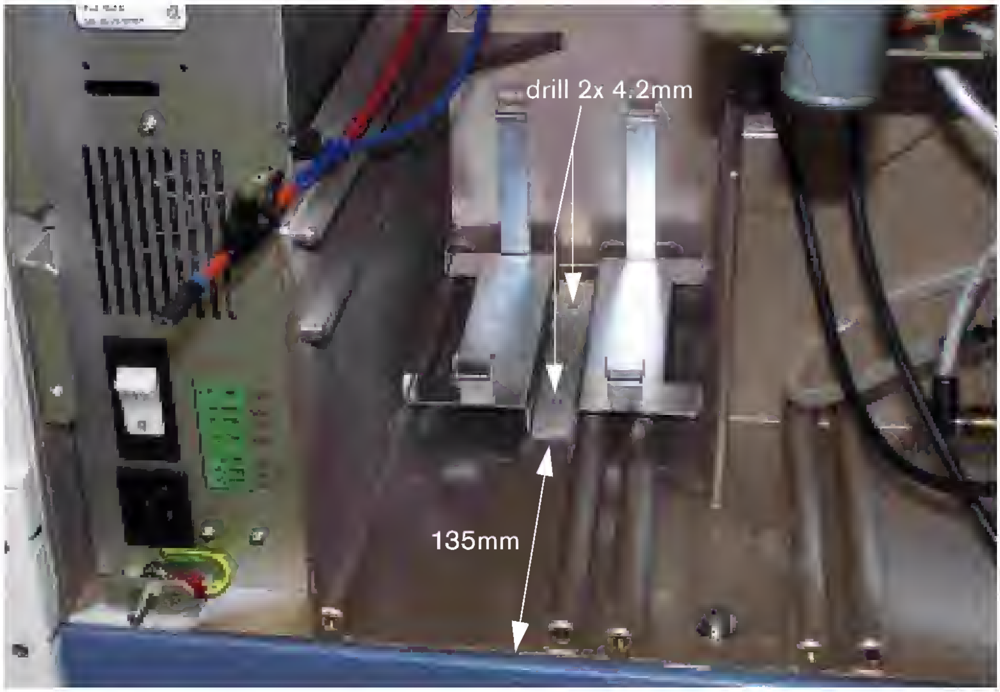


Fig.195: Location of the battery mount

- Mount the battery mount, the batteries, and the retaining rubber bands.

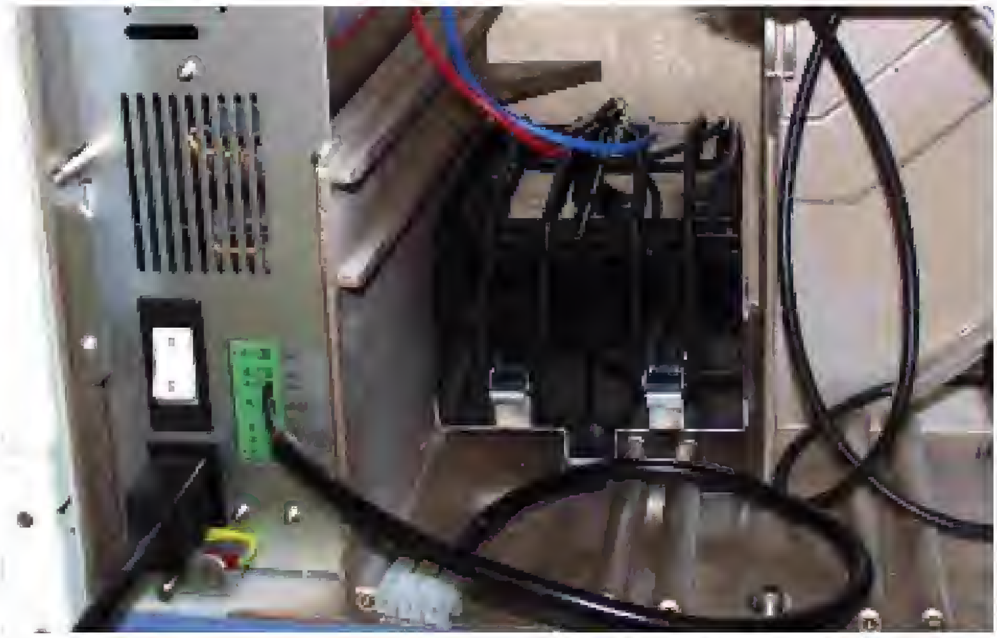


Fig.196: Mounted batteries with retaining rubber bands

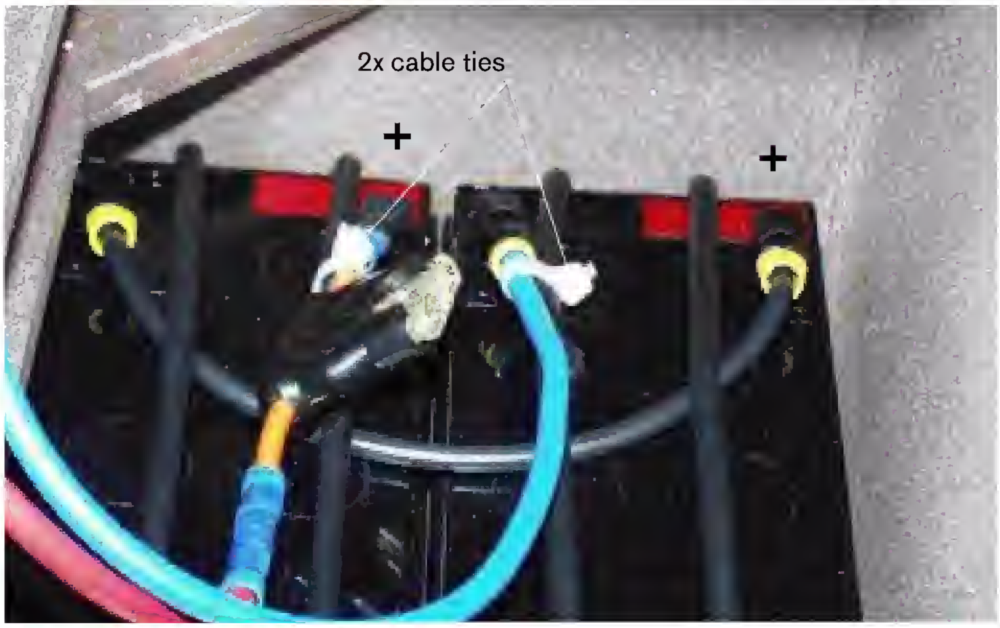


Fig.197: Connecting connection cables and fastening with cable ties

A reversed polarity of battery supply conductors will damage batteries and power supply unit.

- When connecting the battery supply conductors, make sure the polarity is correct (see Fig. 197:).
  Fasten battery supply conductors using cable ties.
- Power Julian from AC outlet, switch Julian ON, and simulate a mains power failure.

Insufficient voltage. The new batteries are not charged sufficiently. Leave Julian connected to AC outlet for at least 10 hours (Julian does not need to be switched ON).

- Perform a VDE test and submit uninterruptible power system (UPS) to a function test according to the Test Certificate.

85 Conversion Instructions for Julian SW 2.02 Light

85.1 Scope of Application

The conversion kit is intended for upgrading Julian 8601125 to current software version 2.02.

85.2 Quantity of Delivery

Conversion kit "SW 2.02 Julian Light" 8601724, ST contains the following items:

1 conversion instructions
2 Instructions for Use
1 set of JULIAN software on 3.5" disks
1 label

85.3 Tools/Test Equipment

85.3.1 Test Equipment:

Basic equipment, including tools for

Software download

– Service PC

– 7901831 software- test programs mt

– 7901808 RS 232 extension cable

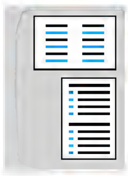
Repair Download

– 7900790 RS 232-converter supplementary equipment

85.4 Procedure

85.4.1 Installation

Install software according to instructions on DORIS CD-ROM.
Activate current safety concept in service mode: electrical (valves V27/V28) or mechanical (flow adjuster).
Deactivate fresh-gas shortage detection in service mode.
Deactivate battery detection in service mode on page "Service2", menu item "continue".



Mark software version on nameplate.
Write serial number of Julian on new Instructions for Use.
Allow Julian to complete self test.

86 Info on SW 3.0n

When upgrading from SW 2 to SW 3.0n, the user will benefit from the following new features:

	New features	Brief description
1	Virtual flowmeter tubes	– O2, N2O, and AIR can be shown as virtual fresh-gas flowmeter on the standard screen. – In service mode, the flowmeter order (O2 -> N2O or N2O -> O2) can be configured.
2	Mixed-gas measurement of two volatile anesthetics	Julian SW 3.0n includes an Iria software update to 3.0: – Quantitative concentration display of primary and secondary (if concentration > 0.1%) anesthetic gas. – Display of MAC values (age correction possible).
3	More accurate I/E ratio setting	– I/E ratio can be set in 0.1 steps in the range of 2/1 to 1/2 or in 0.5 steps in the range of 1/2 to 1/4.
4	Pressure unit in Pa	– The following pressure units can be selected: Pa*100, cmH2O, mbar.
5	Alarm tones	– Pulse length of alarms according to ISO standard.
6	User information	– More detailed text messages are shown during a warm start and when entering safety mode.
7	New language versions	– Hungarian – Catalan – Greek – Turkish
8	Unlimited number of self-test aborts	– Self-test can be aborted as many times as the user wants.
9	"CO2 alarm off" in Man/Spont	– Software version 2.02 had a "CO2 alarm off" message in Man/Spont mode. This plain text message has been replaced by a striked out bell symbol.
10	Inspiratory CO_2 alarm limits are adjustable	– Limits are not fixed to 5 mmHg but can be adjusted by the user.
11	Lower alarm limit for SpO_2 measurement in standby mode is fixed to 80%	

12	Active alarms in Man/Spont	– All alarms in Man/Spont mode can be activated and deactivated.
13	Check list	– The check list prompts the user to check the presence of the valve plates.
14	Self-test indicator	– A bargraph indicates the progress of the self test.
15	Message during shutdown	– A note saying that Julian can be restarted without data loss has been added to the text message shwon during the shutdown procedure.
16	Display of Vt or MV	– The user can choose between Vt and MV on the standard screeen.
17	CO2 curve with two scales	– The user can choose between 0-75 mmHg and 0-110 mmHg.
18	Fresh-gas alarm	– (Additional bellows height recognition hardware required) Fresh-gas alarm is triggered after 3 breaths instead of 1 breath.
19	DC converter fan monitoring	– The correct functioning of the fan is monitored via the internal temperature of the DC converter. The message "Fan?" is generated. Error code 9201 is generated in the error log. – The message "Fan?" is also generated if the ventilator's fan fails or if the internal temperature of Julian is too high (measured by a temperature sensor located on the motherboard).